CITY OF SHORELINE

Planning & Community Development

Medium Impact Project
Technical Guidance Pamphlet
2012

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The Municipal Code (Title 15 Buildings and Construction) can be reviewed at mrsc.org

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MEDIUM IMPACT DRAINAGE PAMPHLET

In order to use the prescriptive Best Management Practices in this pamphlet, your project must be a single family residential project that triggers Minimum Requirements #1 through #5 of the Stormwater Manual and your site soils must be sufficiently permeable.

Many locations in the City of Shoreline have soils that are underlain by a compact layer called glacial till or hardpan which severely limits infiltration capacity and causes water to accumulate at or near the soil surface during the wet season. This can make full infiltration of runoff impracticable, cost prohibitive, unreliable, or all three.

A soils analysis by an approved professional is necessary to determine if soils appropriate for infiltration exist on the property. Approved professionals include licensed engineers, geologists, and on-site wastewater treatment system designers.

Usually, soils which allow the use of either a conventional on-site sewage disposal system or a pressurized sewage disposal system are considered to be sufficiently permeable for most drainage systems included in this manual. Soil suitability will be confirmed as part of the project review.

Generally, single family residential projects proposing 2000 square feet or more of new, replaced or new plus replaced impervious surface or proposing disturbance of more than 7000 square feet of land must meet Minimum Requirements #1 through #5 of the 2005 Department of Ecology (DOE) Stormwater Management Manual for Western Washington. Minimum requirements #1 through #5 are:

1. Prepare stormwater site plans
2. Construct stormwater pollution prevention plan (erosion prevention)
3. Control pollutant sources
4. Preserve natural drainage systems and outfalls
5. Manage stormwater onsite

Please refer to **Figure 1** and **Figure 2**, excerpted from the 2005 Department of Ecology Manual, to determine if your project triggers Minimum Requirements #1 through #5.

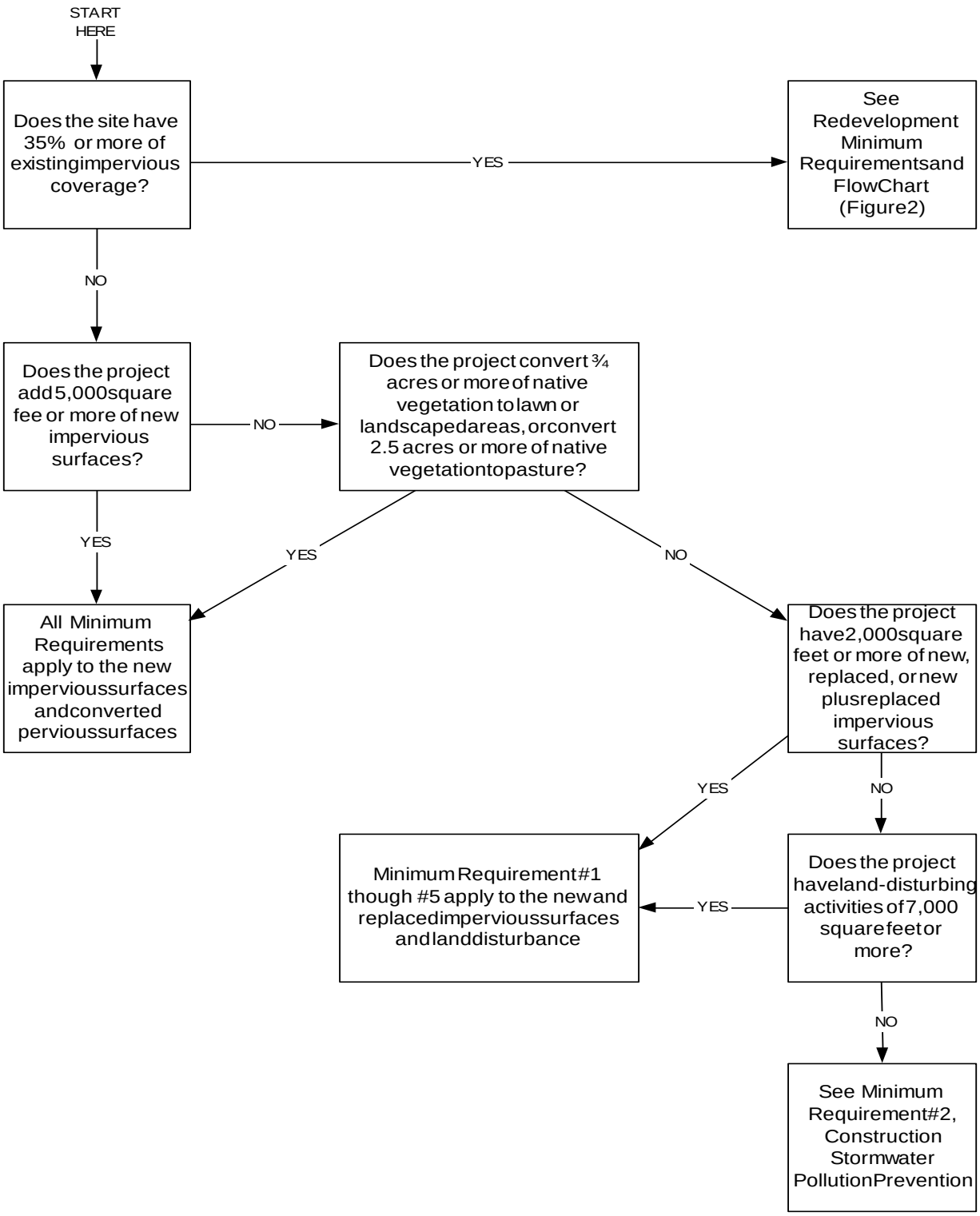

Figure 1 Minimum Requirements for New Projects

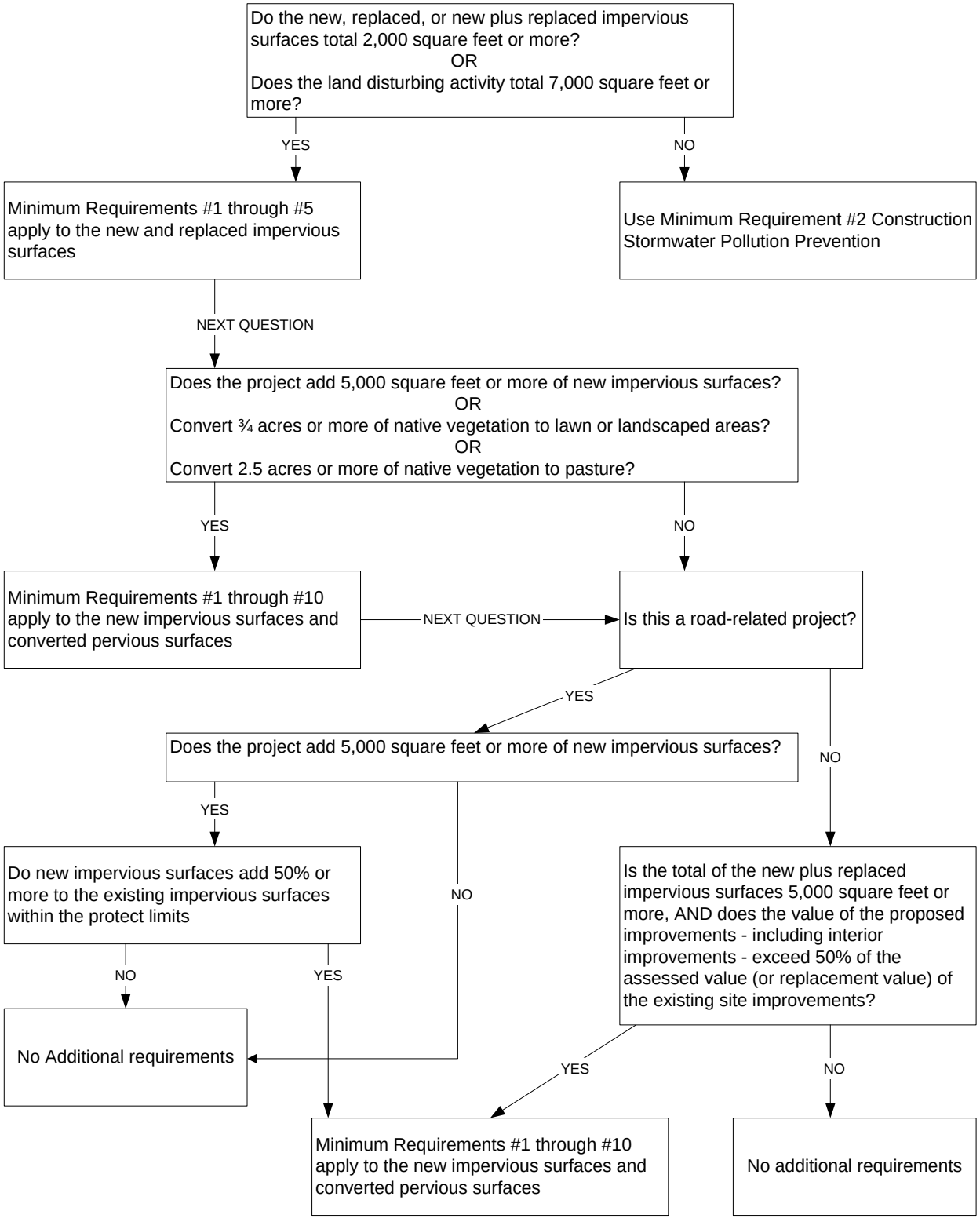

Figure 2 Minimum Requirements for Redevelopment Projects

FIGURES and TABLES

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SECTION I INTRODUCTION

On May 1st, 2009, the City of Shoreline implemented new surface water code that requires Low Impact Development for projects that disturb soils or add, replace or create impervious surfaces. An impervious surface is a surface that can not be penetrated easily. Examples are pavement, patios, roofs, and plastic-covered soils.

Low impact development emphasizes conservation and integration of on-site natural features during development. Careful consideration of existing features onsite and near a site and incorporation of low impact development best management practices can significantly lower stormwater requirements for a project.

Does my project need a permit?

Yes. The drainage design can be approved through a Building permit or through a separate Site Development permit. Please refer to the Shoreline Municipal Code and *Engineering Development Guide*, available on the City's website, for more information on permits.

http://www.shorelinewa.gov/index.aspx?page=251

The following must be submitted with a complete permit application.

- Drainage Plan Submittal form *(See Appendix C)*
- Written Drainage Assessment Form *(See Appendix C)*
- Site Development Plan – to engineer's scale on minimum 24" x 36" paper
- Stormwater Pollution Prevention Plan – to engineer's scale on minimum 24"xX 36" paper
- Soils Report - including infiltration test results

What design professionals do I need?

The detail required for plans submitted for ***Medium Impact*** projects varies considerably. This manual along with some basic measuring and drawing tools should be sufficient for many people to complete an acceptable drainage plan.

In some cases, a qualified professional is required for site assessment. A qualified professional may be a licensed engineer, geologist, or on-site wastewater treatment systems designer.

Projects containing or within 100' of critical areas such as floodplains, streams, wetlands, shorelines, or geologically hazardous areas, must have the drainage plan prepared by a civil engineer licensed in the State of Washington. For a map detailing the critical areas on your site, contact the Permit Services Center at (206) 801-2500 or visit Planning and Development Services.

State law requires that engineering work be performed by or under the direction of a professional engineer licensed to practice in Washington State. All plans prepared by a professional engineer submitted for review must be stamped and signed by the engineer.

Plans involving construction of treatment facilities or flow control facilities, structural source control BMPs, or drainage conveyance systems generally involve engineering principles and should be prepared by or under the direction of a licensed engineer.

Construction Stormwater Pollution Prevention Plans (SWPPPs) that involve engineering calculations must also be prepared by or under the direction of a licensed engineer.

Depending on project scope and location characteristics, the Director may require a licensed professional for any site. If you are not sure, please contact a Development Review Engineer to discuss your project specifics.

The following sections guide the development and design of ***Medium Impact*** project drainage.

Section II **Developing a Medium Impact Drainage Plan** provides guidance to minimize onsite impacts and outlines the required elements the plan.

Section III **Designing Best Management Practices (BMP)** describes the specific requirements, designs, and specifications of each BMP.

The **Appendices** include examples of drainage plans and supporting documents needed for the development of an effective drainage plan.

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SECTION II DEVELOPING A MEDIUM IMPACT DRAINAGE PLAN

Process Outline

The steps described below outline the process for development of a ***Medium Impact Drainage Plan***. The goal is to minimize land disturbance and impervious surfaces such as roofs and driveways, and maximize protection of soil and vegetation.

1. Use the Medium Impact Project Submittal Form in Appendix C as a guide to the types of information you will need.
2. Conduct a site inventory to determine existing patterns of water movement and vegetated areas on your site. Consider ways your proposed development can avoid impacts to them.
3. Obtain an accurate topographic map for the site to use as a basis for the drainage plan. This can be as simple as a map that denotes flat areas, sloped areas with approximate percent grade, and drainage paths. Topographic information for your site can be found on the King County IMAP website or through Planning and Development Services.
4. Determine if there are locations on the site that will infiltrate. Perform soils analysis.
5. Decide which areas must be protected from equipment and other compaction sources in order to preserve infiltration capacity.
6. Select options for managing roof runoff, driveway runoff, conveyance areas, and end-of-line discharge areas using the Site Planning Tips and Best Management Practices - Overview.
7. Consult Section III of this manual for details on the design and applicability of each of the BMP options.
8. Use the sizing charts located in Section III to determine the required dimensions for each BMP based on the project type (i.e. new development or re-development.)
9. Sketch your site development/drainage plan. The plan must show 1) the square footage of the impervious areas such as roof, patio, and driveway, 2) the technique for managing the runoff generated by the impervious surfaces and 3) the runoff path from the source to the end-of-line discharge method.

If your project is somewhat large or complex, it is suggested at this point to have a professional engineer design the plan and create the plan drawings for submittal.

Site Planning Tips

The following are tips for creating a project or development that minimizes the impact your construction project will have on the patterns of water flow and vegetated areas of the site and help facilitate stormwater infiltration on the property:

1. Identify the soil type(s) on your project site in order to determine which stormwater management techniques in this manual will be applicable for your site
2. Place structures as close to the public access point as possible to minimize road/driveway length. Minimize paved and gravel parking areas, and utilize porous paving options wherever possible.
3. Slope paved areas to facilitate drainage to stormwater management areas.

4. Reduce building footprints whenever possible. Utilize basements or taller structures with lofts or second stories to achieve square footage goals.
5. Orient buildings on slopes with long-axis along topographic contours to reduce grading requirements.
6. Set clearing limits that give maximum protection to soils and vegetation while allowing reasonable areas for equipment to maneuver on the site. Delineate the areas both on the construction plans and on the ground with temporary fencing or taping.

Best Management Practices (BMPs) – Overview

RUNOFF MANAGEMENT BMPS

The Runoff Management section (Section III A) of this manual presents general guidelines for design of BMPs for managing runoff from impervious surfaces such as roofs and driveways as well as specific sizing requirements for each. In a Medium Impact Drainage Plan there are many options to manage stormwater runoff from roofs and paved areas.

Basic Dispersion. Projects which add or replace less than 2000 square feet of impervious surface may be able to use basic dispersion (splash blocks) for the runoff management portion of the plan; conveyance and end-of-line discharge BMPs may still be required.

Standard Runoff. For projects that add or replace more than 2000 square feet of impervious surface, one or more of the following are required:

1. Rain Gardens
2. Rainwater Planters
3. Rainwater Dispersion
4. Infiltration Systems
5. Runoff Filter Strips
6. Porous Pavement
7. Rainwater Collection

STORMWATER CONVEYANCE BMPS

The stormwater conveyance section (Section III B) of this manual presents general guidelines for conveying stormwater on your site. The stormwater conveyance BMPs serve to both convey stormwater from, and if necessary to, a runoff management area such as a rain garden or infiltration trench, and to slow flows as they travel across and from a developed site. There are four options for the conveyance of stormwater on the site:

1. Swales
2. Conveyance Furrows
3. Conveyance Gardens
4. Gravel Trenches

END-OF-LINE DISCHARGE BMPS

Discharge BMPs (Section III B) provide a means for stormwater from a developed lot to disperse in a slow and diffuse manner to prevent concentration and associated channeling. End-of-Line Discharge BMPs are designed to be used to disperse stormwater on-site and are not be used to disperse stormwater outside the project property's boundaries. These options are outlined in the End-of-Line Discharge section of the manual. They include:

1. Level Spreaders
2. Quarry Spall Pads
3. Continued Dispersion

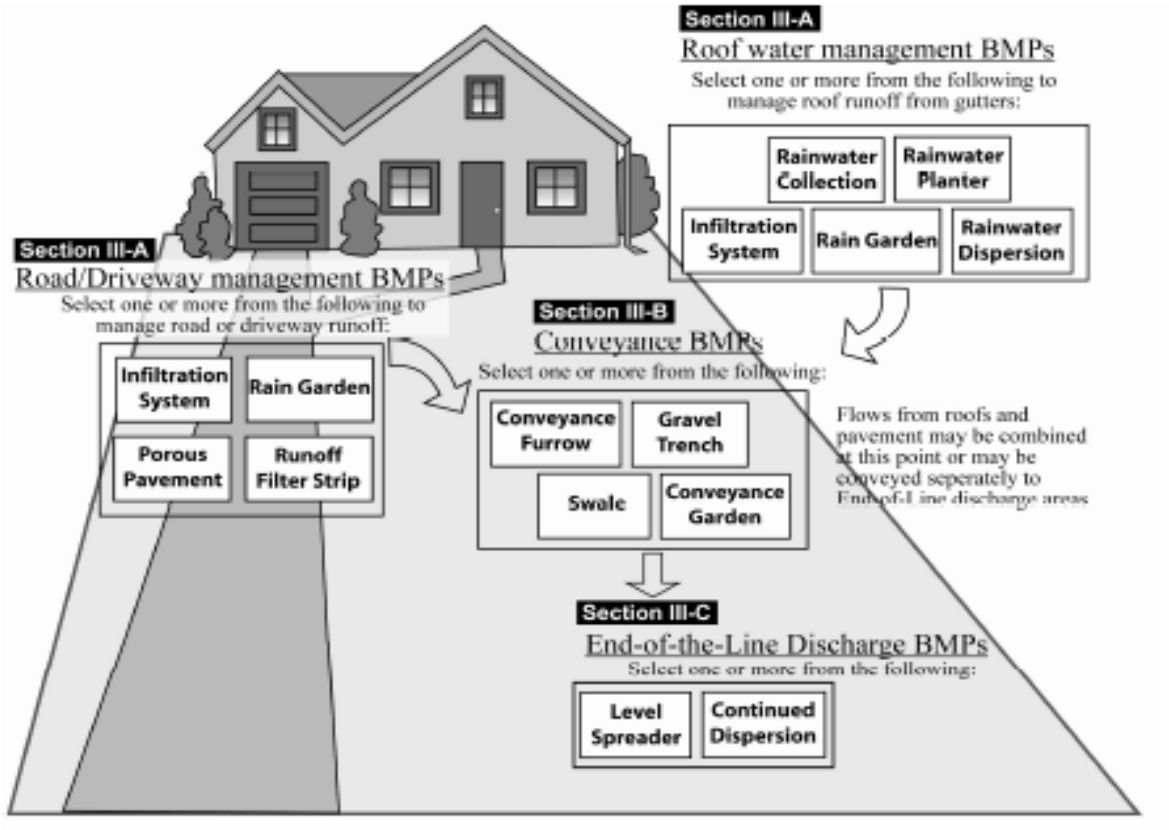

Figure 3 Drainage Planning Flowchart

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SECTION III DESIGNING BEST MANAGEMENT PRACTICES (BMPs)

Section III-A Runoff Management BMPs

Runoff management is the main component of a Medium Impact Drainage Plan. This manual includes a basic dispersion option for projects less than 2000 square feet of new and/or replaced impervious surfaces, and seven standard options to manage stormwater from roofs and paved areas on larger projects.

BASIC DISPERSION RUNOFF MANAGEMENT

Projects on level and gently sloping ground which create less than 2000 square feet of new and redeveloped impervious surfaces may use basic dispersion for runoff management.

In general, if the ground is sloped away from the foundation, and there is adequate vegetation for effective dispersion, splash blocks will adequately disperse storm runoff into and or across the soil. If the ground is level, adding downspout extensions to move the discharge point further from the foundation may be a better choice. Conveyance and end-of-line discharge BMPs may be required.

The following requirements apply to basic dispersion:

1. The developed lot area must be predominately flat to gently sloped, with slopes of no more than 10% in the path of the dispersed flows.
2. When utilizing *Basic Dispersion*, no more than 700 squarefeet of roof area may be drained to a single splash block. All existing, new, and replaced roof areas on the site are required to meet these requirements.
3. When new or replaced pavement is included in the project, the design of the pavement shall disperse runoff evenly along at least one side of the driveway to the extent practical.
4. A turf or other vegetated flow path of at least 50’ in length must be available along the path that runoff will follow upon discharge from the splash block to the nearest property line or a conveyance BMP and a discharge BMP is required.

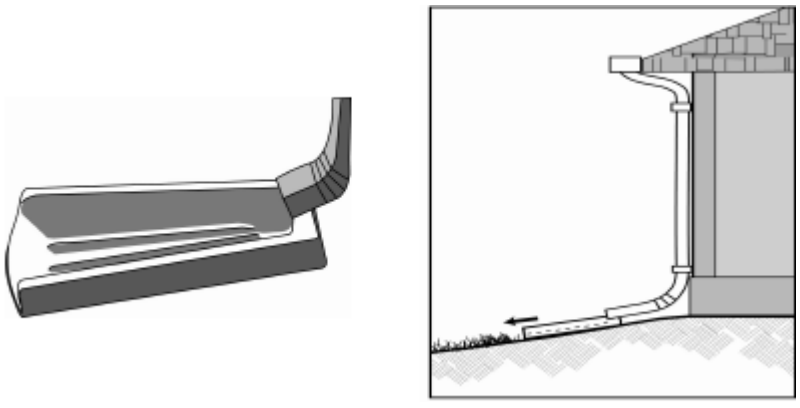


Figure 4 Splash block (Basic Dispersion)

STANDARD PROJECT RUNOFF MANAGEMENT

Projects adding more than 2000 square feet of new or replaced or new plus replaced impervious surface must provide runoff management using one or more of the following options for the entire site. Projects which are redevelopments of existing developed lots may use the redevelopment design numbers included in the sizing tables. The main features and preferred application for each option are summarized below. Details of each option are explained in the following sections.

1. **Rain Gardens**

   Rain gardens are excavated basins in which runoff accumulates and slowly infiltrates or flows out through a medium outlet opening.

   One of the most versatile options, rain gardens can be placed in any soil type and on most sites and should be the primary runoff management technique for most sites.

2. **Rainwater Planters**

   Rainwater planters are basins with raised sides of wood or concrete in which runoff accumulates and slowly infiltrates or flows out through Medium weep holes to surrounding surfaces.

   Planters are a good option where they can be installed near roof downspouts.

3. **Rainwater Dispersion**

   Dispersion emphasizes use of vegetated areas to receive dispersed stormwater.

   Requires at least 50% vegetated open space on site with a drainage easement.

   Best on slopes less than 10% where runoff is easily routed to vegetated areas.

4. **Infiltration Systems: Trenches and Drywells**

   Infiltration utilizes gravel-filled basins or trenches to infiltrate runoff into porous soil.

   Requires soil with sandy or gravelly texture without high water table.

   Infiltration systems may clog with sediment over time and require replacement.

5. **Runoff Filter Strips**

   Runoff filter strips are large roadside areas of sandy or gravelly soil covered with turf which allow filtering, storage and infiltration of paved area runoff.

   The filter strip area must be equal to that of the impervious paved area it is adjacent to (such as the driveway), excavated and filled with sand or gravel.

6. **Porous Pavement**

   Porous pavement allows rainwater to seep through the hardened surface through pores and spaces in the pavement.

   Porous pavement should be placed on slopes less than 5%.

7. **Rainwater Collection**

   Rain barrels and cisterns are containers in which roof runoff is collected for later use or release. These options have limitations on size and application. They can only collect

roof runoff and the collected water is suitable for nonpotable uses only. They also require careful management to control and manage overflow.

1. RAIN GARDENS

Rain gardens are excavated depressions lined with amended soil and planted with vegetation capable of thriving in wet soil in the winter and dry conditions in the summer.

Rain gardens provide bioretention, a process in which storm runoff is temporarily captured in vegetated basins, where physical and biological processes improve water quality and lessen flows before they enter public or other drainage systems.

Rain gardens are the simplest, easiest to maintain, and most fool-proof option for runoff management and should be included as the primary runoff management option for most projects. The table below serves as a guide to determine the surface area of the rain garden based on the amount of impervious surface area draining to the garden and type of development activity. To calculate the required are for the rain garden multiply the impervious area by 17% for new development and for re-development multiply by 13%.

Table 1 Rain Garden Sizing

		Square Footage of Impervious Surface Draining to the Garden							
		500	1000	15000	2000	2500	3000	4000	5000
Required Area of Rain Garden (SF)	Redevelopment	65	130	195	255	320	380	510	635
	New Development	85	170	255	340	425	510	680	850

Example: A new 3000 square-foot house would require a rain garden with a surface area of 510 square feet. (3000 square feet x .17 = 510 square feet)

If you utilize a rain garden to control stormwater runoff, you will need to follow the guidelines below:

Rain gardens should be located on level to gently sloped ground. Use caution in locating rain gardens on slopes greater than 10%.

1. Rain gardens shall be built to the required size as shown in the sizing table above.
2. Rain gardens shall have a minimum depth of 2’.
3. Side slopes shall be 2 horizontal to 1 vertical or less.
4. Rain gardens shall include outlets consisting of a 4” pipe with a cap with a 1” hole to meter the outflow. The hole in the cap should be increased to 1.5” for rain gardens with over 4000 square feet of impervious draining to them. A 4” tee and standpipe approximately 16” tall shall be installed to provide overflow to the drain line in the event of high water levels. This prevents overtopping of the rain garden.
5. The rain garden shall include an additional overflow either by surface sheet flow or stabilized rock spillway to a level spreader, ditch or other stormwater dispersal system.
6. The rain garden should be planted with vegetation appropriate for moist and seasonally dry conditions.

For a list of recommended plants refer to Appendix B or to an excellent handbook for rain garden construction produced by Washington State University Pierce County Extension is available at:

http://www.pierce.wsu.edu/Water_Quality/LID/

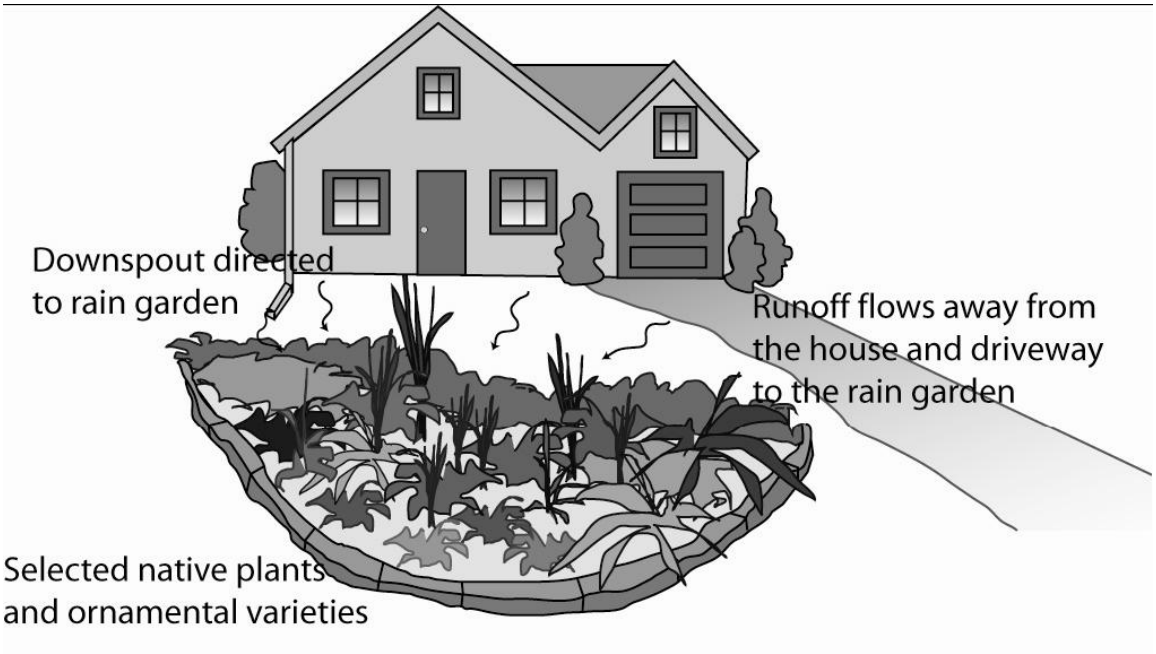


Figure 5 Rain Garden Example

Rain Garden Operation and Maintenance

Rain gardens are vegetated depressions that retain and filter stormwater from an area of impervious surface. The plant growth in the rain garden serves to filter the water and sustain infiltration. Depending on soil conditions, rain gardens may have water in them throughout the wet season and may overflow during major storm events.

The size, placement, and design of the rain garden as depicted by the drainage plan must be maintained and shall not be changed without written approval from The City of Shoreline Development Review Engineer.

Generally the following operation and maintenance activities should be considered:

1. Plant materials may be changed to suit tastes, but chemical fertilizers and pesticides must not be used. Additional mulch and compost should be added to the rain garden periodically.
2. Rain gardens must be inspected annually by the property owner for physical defects.
3. After major storm events, the rain garden should be checked to see that the overflow system is working properly and is not clogged.
4. If erosion channels or bare spots are evident, they should be stabilized with soil, plant material, and mulch.
5. A supplemental watering program may be needed the first year to ensure the long-term survival of the rain garden's vegetation.
6. Vegetation should be maintained as follows:
7. Replace all dead vegetation as soon as possible;
8. Remove debris as needed;
9. remove all noxious vegetation when discovered;
10. Manually weed without herbicides or pesticides;
11. Mulch to conserve moisture and inhibit weed germination.

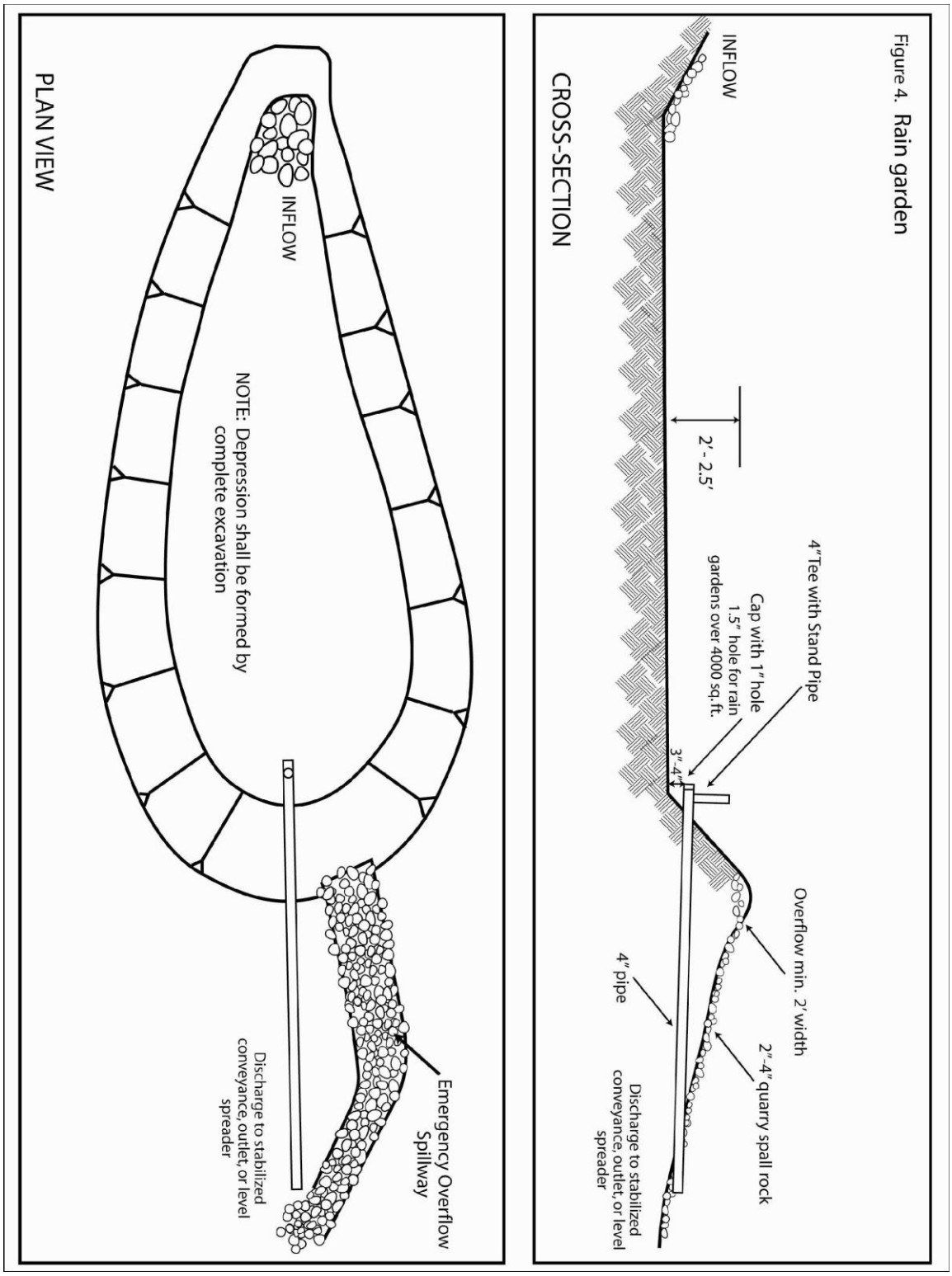


Figure 6 Rain Garden Plan and Cross Section

2. RAINWATER PLANTERS

Rainwater planters are much like raised, above ground rain gardens. Generally planters are used for runoff from roofs and are built so that downspouts empty directly into the planter. Planter sides may be constructed of treated wood, concrete, or brick. Planters may be constructed with open contact to the ground or with impervious bottoms with side weep holes of ½" to 1" in diameter. The bottom layer shall be clean gravel with a 1 foot minimum depth covered by a minimum of 1 foot of topsoil. The planter must include an overflow notch or pipe and be designed to drain to a conveyance BMP with a minimum 1 foot of water storage depth.

Sizing for rainwater planters is the same as for rain gardens (see Table 1 in the Rain Garden section). The rainwater planter should be planted with vegetation appropriate for moist and seasonally dry conditions. Trees and large shrubs are not recommended. See Appendix B for a list of recommended plants.

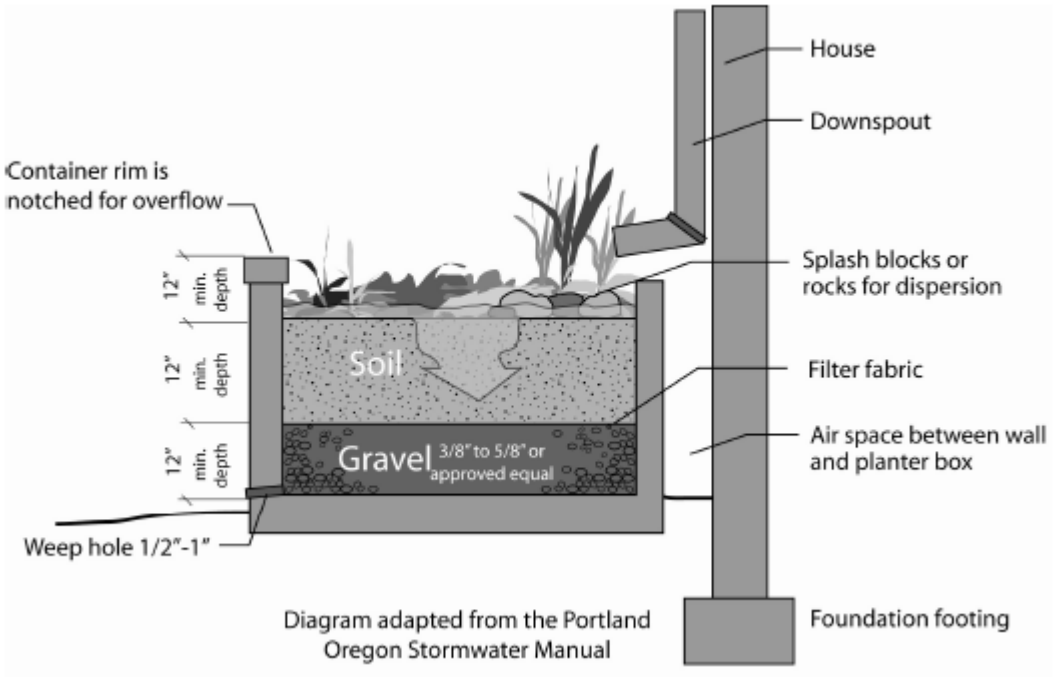


Figure 7 Rainwater Planter Cross Section

Rainwater Planter Operation and Maintenance

Rainwater planters are containers designed to intercept rainfall that would normally fall on impervious surfaces and store and release the captured stormwater at a slower rate.

The size, placement, and design of the rainwater planter as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.

Generally the following operation and maintenance activities should be considered:

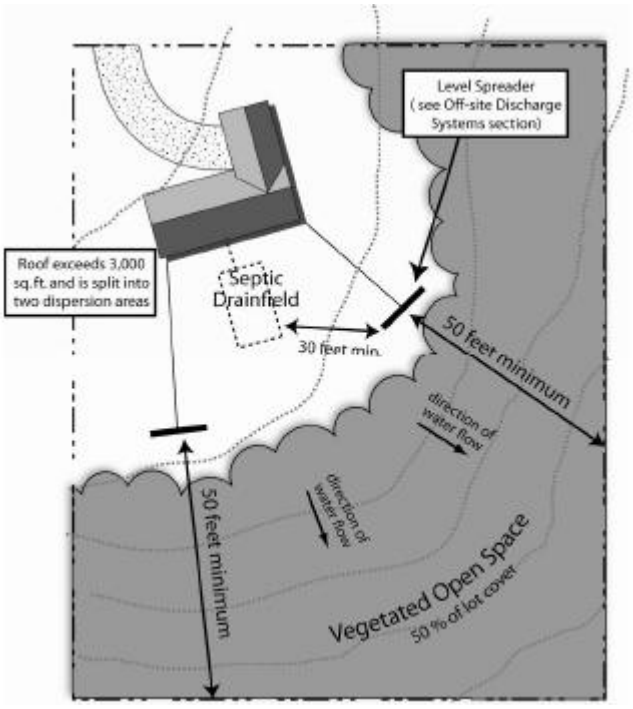
1. Chemical fertilizers and pesticides must not be used.
2. Additional mulch and compost should be added to the rainwater planter periodically.
3. Rainwater planters must be inspected annually by the property owner for physical defects. Structural deficiencies in the planter including rot, cracks, and failure shall be repaired. Holes that are not consistent with the design and allow water to flow directly through the planter to the ground shall be plugged.
4. After major storm events, the rainwater planter should be checked to see that the drainage system is working properly and is not clogged. If stormwater is not draining properly, the planter shall be excavated and cleaned, and gravel or soil shall be replaced to correct low infiltration rates.
5. A supplemental watering program may be needed the first year to ensure the long-term survival of the rain garden's vegetation.
6. Vegetation should be maintained as follows:
7. Replace all dead vegetation as soon as possible;
8. Remove debris as needed;
9. Remove all noxious vegetation when discovered;
10. Manually weed without herbicides or pesticides;
11. Mulch to conserve moisture and inhibit weed germination.

3. RAINWATER DISPERSION

Rainwater dispersion is a strategy that emphasizes minimization of impervious surfaces and evenly dispersing runoff into vegetated areas on your property. In order to utilize dispersion, a lot can not have more than 15% impervious surface and must maintain at least 50% of the lot area in vegetated open space protected by a conservation easement. Vegetated open space includes native undisturbed areas and rehabilitated previously disturbed areas. Active recreation areas and lawn shall not count towards vegetated open space. Dispersion is a good option for large lots.

The following basic requirements apply to sites utilizing rainwater dispersion; additional measures may be required if site conditions warrant:

1. The developed lot area must be predominately flat with slopes of no more than 10%.
2. Areas of vegetated open space should be delineated clearly on the drainage plan.
3. The maximum lot impervious surface area is 15%.
4. At least 50% of the total lot area shall be protected with a drainage easement granted to The City of Shoreline
5. A vegetated flow path of at least 50’ in length must be available along the path that runoff will follow upon discharge to the nearest property line.
6. A minimum 100-foot vegetated buffer from the point of dispersion to a critical area or its buffer such as a stream or wetland.



Careful attention must be paid to spreading the stormwater properly. Runoff from each distinct impervious area should be dispersed to different areas and combining the flows from different areas should be kept to a minimum.

No more than 3000 square feet of impervious surface shall be routed to one area for dispersion.

Figure 8 Rainwater Dispersion Example

Rainwater Dispersion Operation and Maintenance

Dispersion is a strategy for minimizing the area disturbed by development, retaining native vegetated areas and applying dispersion techniques that utilize the natural capacity of vegetation to mitigate the stormwater runoff quantity.

This flow control BMP has two primary components that must be maintained:

(1) The dispersal flow path; and

(2) The vegetated open space.

(1) Dispersion Flow path

a. The size, placement, composition, and downstream flow paths of these devices as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.

b. Dispersion devices such as splash blocks and level spreaders must be inspected annually by the property owner and after major storm events to identify and repair any physical defects. See Section III C for a description of level spreaders.

c. When native soil is exposed or signs of erosion are present, the sources of the erosion or concentrated flow shall be identified and mitigated. Bare spots should be re-vegetated with native vegetation.

d. Concentrated flow can be mitigated by leveling the edge of the pervious area and/or replenishing the rock in the dispersion device, such as in gravel-filled trenches.

(2) Vegetated Open Space

The vegetated surface required for dispersion should be delineated as "vegetation retention area" on the drainage plan.

The trees, shrubs, ground cover, and soil conditions in this area shall not be disturbed, except as allowed by the following provisions:

a. Individual trees that have a structural defect due to disease or other defects, and which threaten to damage a structure, road, parking area, utility, or place of employment or public assembly, or block emergency access, may be topped, pruned, or removed as needed to eliminate the threat.

b. Dead or fallen trees, tree limbs within 10' of the ground, and branches overhanging a residence may be removed to reduce the danger of wildfire.

c. Noxious weeds (i.e., plant species listed on the State noxious weed list in Chapter 16-750 WAC) and invasive vegetation (i.e., plant species listed as obnoxious weeds) shall be removed.

d. Passive recreation uses and related facilities, including pedestrian, equestrian and bicycle trails, nature viewing areas, fishing and camping areas, and other similar uses that do not require permanent structures, are allowed if clearing and soil compaction associated with these uses and facilities does not exceed 10 % percent of the vegetation retention area.

4. INFILTRATION SYSTEMS: TRENCHES AND DRYWELLS

Infiltration systems are BMPs that are designed to allow runoff to be absorbed into the ground. Soil conditions must be favorable enough to assure that the device used to soak water into the ground (e.g., infiltration trench, drywell, etc.) will perform as expected. Many locations in Shoreline have soils that are underlain by a compact layer of soil called glacial till or hardpan which severely limits infiltration capacity and causes water to accumulate at or near the soil surface during the wet season. This can make full infiltration of runoff impracticable, cost prohibitive, unreliable, or all three.

Sites outside these areas may require a soils analysis by an approved professional to allow infiltration systems. Approved professionals include licensed engineers, geologists, and on-site wastewater treatment system designers.

If you plan to utilize infiltration trenches or drywells to control stormwater runoff, you will need to follow the guidelines listed below:

1. In your drainage plan include locations of proposed drywells and trenches with their sizes. Indicate which roof areas will be routed into each.
2. Runoff from paved areas including driveways and parking areas should flow through or across a vegetated strip or swale prior to infiltration.
3. Infiltration systems must be appropriately sited with respect to the locations of slopes, wells, and building foundations so as not to adversely affect them. Infiltration systems must be down gradient at least 10’ from foundations, and 100’ from wells. Infiltration systems shall be located on flat or gently sloped ground with grades of less than 15%.
4. Infiltration systems must be filled with washed drain rock (1 ½” to 3” in diameter). The top and sides must be covered and wrapped with filter fabric so that the fine soils do not migrate into the voids of the drain rock. Landscaping cloth (generally available at hardware stores) works well for this purpose. A screen must be provided either at the outlet of the downspout or at the inlet to the drywell pipe to keep debris from entering the system.
5. Connections between the infiltration system and the conveyance system such as swale, conveyance garden, or gravel trench should utilize one of the following:
    a. 3” - 4” pipe buried not more than 6” below grade at least 2’ in length.
    b. 8” wide x 8” deep gravel trench at least 2’ in length
    c. Shallow earthen slot 4” deep and 4” wide

Consult the following pages for specifics on different infiltration techniques.

Infiltration Trench

Infiltration trenches are shallow gravel-filled trenches where runoff water is routed for storage and infiltration. Infiltration trenches work best in sandy or gravelly soil (generally hydrologic group A and B) and are not appropriate in some clayey soil types (hydrologic groups C and D). Runoff from paved areas including driveways and parking areas should flow through or across a vegetated strip or swale prior to infiltration. Infiltration trenches are sized according to the amount of impervious surface and the type of development. The table below can be used to determine the surface area needed for an infiltration trench based on the type of project and the amount of stormwater draining to the trench. For new development multiply the impervious area by 30%, for re-development multiply by 22%.

Table 2 Infiltration Trench sizing.

		Square Footage of Impervious surface Draining to Infiltration Trench							
		500	1000	1500	2000	2500	3000	4000	5000
Required Surface Area of Trench (SF)	Redevelopment	115	230	340	450	560	675	900	1125
	New Development	150	300	450	600	750	900	1200	1500

The Infiltration Trench should be a minimum of 2’ deep.

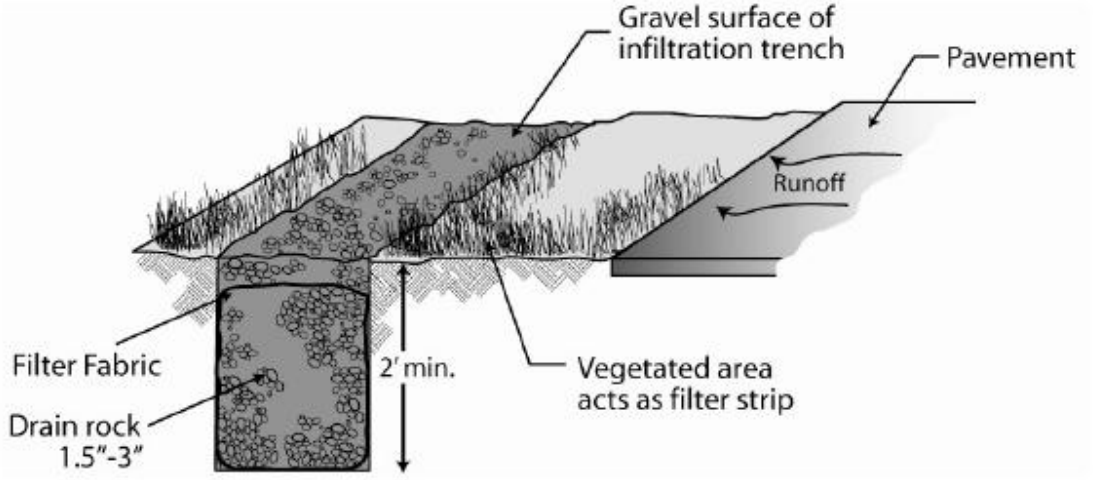


Figure 9 Infiltration Trench Cross Section.

Drywell

A drywell is a simple, gravel-filled hole with a bottomless catch basin in the center into which runoff from the downspouts and gutters is routed. Drywells give a limited storage space for runoff to infiltrate slowly into the surrounding soil. Individual drywells can be used to manage runoff from up to 1500 square feet of impervious surface area. Multiple drywells may be needed to manage the stormwater runoff on your property. Drywells are appropriate for sandy or gravelly soil types (generally hydrologic group A and B).

Drywells are sized according to the amount of impervious surface and the type of development. The table below can be used to determine the necessary size for the drywell based on the type of project and the amount of stormwater draining to the drywell.

Table 3 Drywell Sizing

		Square Footage of Impervious Surface Draining to Drywell				
		500	750	1000	1250	1500 max.
Required size of dry well (SF)	Redevelopment	8’ x 8’	10’ x 10’	12’ x 12’	13’ x 13’	14’ x 14’
	New Development	9’ x 9’	11 ’x 11’	13’ x 13’	14’ x 14’	15’ x 15’
	Required catch basin size*	Type 1	Type 1L	2-Type 1L	1-48” Type II	1-54” Type II

*Catch basins may be purchased from local concrete distributors.

The drywell should be a minimum of 5’ deep.

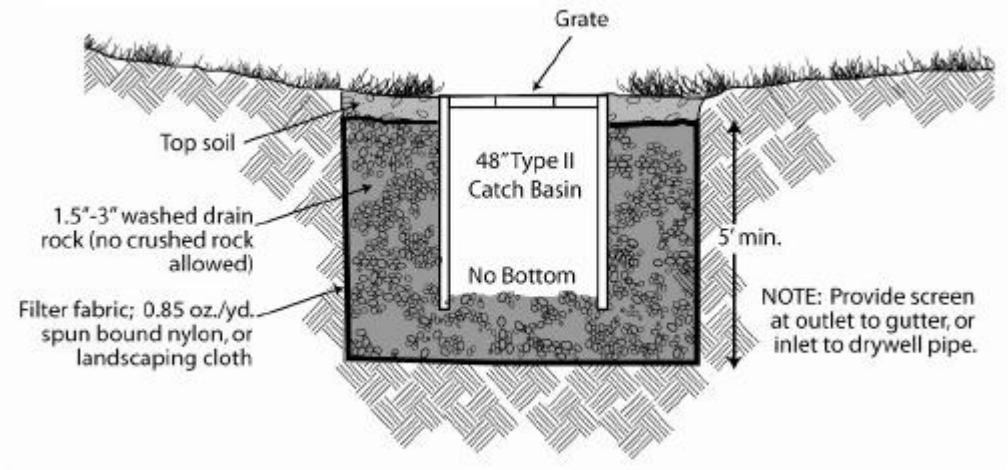


Figure 10 Drywell Cross Section

Infiltration Systems Operation and Maintenance

1. Infiltration systems are designed to absorb runoff from impervious area (such as paved areas and roofs) into the ground. To be successful, the soil condition around the infiltration device must be reliably able to soak water into the ground.
2. The size, placement, and composition of these devices as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Department of Planning and Development Services.
3. Infiltration systems must be inspected annually by the property owner and after major storm events to identify and repair any physical defects.
4. Maintenance and operation of the system should focus on ensuring the system's viability by preventing sediment-laden flows from entering the device. Excessive sedimentation will result in a plugged or non-functioning facility. If the infiltration device has a catch basin, sediment accumulation must be removed on a yearly basis or more frequently if necessary. Annual inspection should be conducted to ensure system has not become clogged.
5. Prolonged ponding around or atop a device may indicate a plugged facility. If the device becomes plugged, it must be replaced.
6. Keep the areas that drain to infiltration devices well swept and clean to enhance the longevity of these devices. For roofs, frequent cleaning of gutters will reduce sediment loads to these devices.

5. RUNOFF FILTER STRIPS

Runoff filter strips are lawn areas underlain by 1’ to 1.5’ of sand or gravel that are adjacent to driveways or parking areas. The turf and sand filter pollutants from runoff and allow stormwater to slowly infiltrate into the underlying soil.

Runoff filter strips shall encompass an area equal to or larger than half the impervious surface area that drains to them. For paved areas of 2000 square feet or less, no other runoff management option is required. For paved areas larger than 2000 square feet, additional runoff management may be required.

Recommended additional runoff management options for larger paved areas should be designed at one-third the standard sizing for regular impervious areas. For example, a runoff filter strip half the size of the impervious surface area along with a rain garden 1/3 the size of the rain garden sizing in Table 1 recommendation would fulfill the runoff management needed for paved areas larger than 2000 square feet.

Examples:

1. A 1500 square-foot paved driveway would require a filter strip totaling an area of 750 square feet. No additional runoff management is needed for the paved area.
2. A 2500 square-foot paved driveway would require a filter strip with a surface area of 1250 square feet *in combination with*:

    a. A rain garden with a surface area of 141 square feet, which is 1/3 of 425 square feet needed according to the rain garden sizing in Table 3 for 2500 square feet of impervious surface.

    OR

    b. An infiltration trench with a surface area of 250 square feet, which is 1/3 of 750 square feet needed according to the infiltration trench sizing in Table 2 for 2500 square feet of impervious surface.

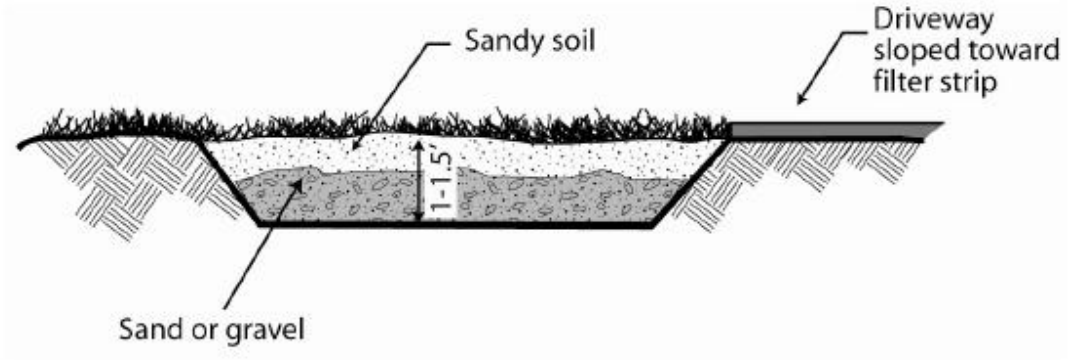


Figure 11 Runoff Filter Strip Cross Section

Runoff Filter Strip Operation and Maintenance

Runoff filter strips are lawn areas that stormwater runoff is directed to flow and filter through. Pollutants are removed through infiltration and sedimentation.

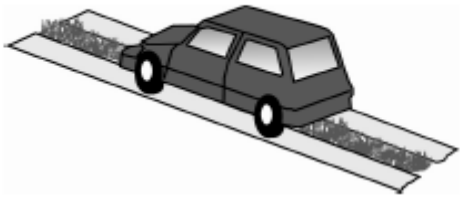
The size, placement, and composition of the filter strips as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.

1. Keep the areas that drain to the filter strip well swept and clean to enhance the longevity of the strip. For roofs, frequent cleaning of gutters will reduce sediment loads to these devices.
2. Sources of erosion damage shall be identified and controlled when soil is exposed or erosion channels are forming.
3. Sediment build-up in the filter strip that exceeds 2" in depth shall be removed.
4. If the filter strip does not drain within 48 hours, it shall be regraded and reseeded.

6. POROUS PAVEMENT

1. Porous pavements are designed to accommodate vehicle and pedestrian traffic, while allowing infiltration, stormwater treatment, and limited stormwater storage. Porous pavement can be used in many standard pavement applications. For paved areas of 2000 square feet or less, no other run-off management option is required. For areas larger than 2000 square feet, additional run-off management may be required.
2. Recommended additional run-off management options for porous paved areas exceeding 2000 square feet should be designed at one-third the standard sizing for regular impervious areas. For example, a filter strip 1/6 the width of the driveway would fulfill the additional runoff management requirement.
3. Porous pavement is constructed above a gravel base of generally 1" to 1.5" of compacted, washed angular gravel with finer material or sand on top. A variety of types are available including porous asphalt and concrete, pavers, and concrete or plastic cellular paving systems. As most porous pavements have standard specifications, follow the manufacturers' recommendations.
4. Use of porous pavement is restricted to sandy or gravelly soil types (hydrologic group A and B). Sites may require a soils analysis by an approved professional to allow use of porous pavement. Approved professionals include licensed engineers, geologists, and on-site wastewater treatment system designers.
    a. A minimum depth to seasonal ground water of 2' is required to utilize porous pavement.
    b. Porous pavement should be used on flat to gently sloped ground with a maximum slope of 5%.
    c. The type and location of porous pavement shall be marked on the drainage plan.
    d. Porous pavements should be used in low-speed applications only, i.e. walkways, driveways, fire lanes, overflow parking, etc. Plastic cellular paving systems with turf shall be restricted to low-use applications such as overflow parking, shoulders, etc.
    e. Porous pavement should be designed with adequate drainage to prevent water from remaining in pavement or base material for over 24 hours.

Engineering consultation is strongly recommended for all systems.



Hollywood Driveway

A Hollywood driveway, a driveway constructed with a center grass strip, is a simple and effective way to reduce impervious surface. **When a Hollywood driveway is constructed with a permeable gravel base and sand under the sod and soil layers, it shall be considered a porous pavement option.**

Porous Pavement Operation and Maintenance

1. Porous pavements reduce the amount of rainfall that becomes runoff by allowing water to seep through the pavement into free-draining gravel or sand bed, where it can be infiltrated into the ground.
2. The area covered by porous pavement as depicted on the drainage plan must be maintained as porous pavement and cannot be changed without written approval from the City of Shoreline Development Review Engineer.
3. Porous pavements must be inspected after major storms by the property owner to make sure it is working properly. Prolonged ponding or standing water on the pavement surface is a sign that the system is defective and may need to be replaced.
4. To help extend the useful life of the system, the surface of the porous pavement should be kept clean and free of leaves, debris, and sediment through regular sweeping or vacuum sweeping.
5. The owner is responsible for the repair of all ruts, deformation, and/or broken paving units. A typical porous pavement system has a life expectancy of approximately 25 years.

7. RAINWATER COLLECTION

Rainwater can be collected off of roofs and routed to containers such as rain barrels or cisterns for storage and later use. Up to 2500 square feet of impervious surface may be mitigated by the use of rainwater catchment. Medium systems of up to 2200 gallons with water use restricted to non-potable outdoor uses can be incorporated into a drainage plan without engineered designs, although engineering consultation is strongly recommended for all systems.

Engineering consultation is strongly recommended for all systems.

Table 4 Cistern Sizing

Roof Area draining to Cistern (SF)		250	500	1000	1500	2000
Cistern Volume (gallons)	All Development	500	1100	2200	3300*	4400*

* Requires engineer design.

1. Rainwater catchment systems are subject to Department of Ecology rules.
2. Rainwater catchment can be used as the sole runoff management option for roofs up to 1250 square feet and for up to 50% credit for additional roof areas. To receive credit for roof areas routed to cisterns or rain barrels, the storage volume must equal or exceed the amounts required in the sizing table above.
3. In order for rainwater catchment to aid in reducing flows from developed areas, it is important to manage overflow during storms. Ideally, spigots should be shut off during stormy periods, and overflow routed to additional BMPs such as a rain garden or infiltration trench. Storage levels should be kept to less than ¾ full by slowly lowering levels during dryer weather by irrigating lawns or gardens or very slowly draining to conveyance areas. Larger clean-out valves should not be used to lower water levels especially during winter months. Water from the cistern should be drained prior to freezing weather.
4. If you plan to utilize a cistern or rain barrels to collect stormwater runoff, follow the guidelines below:
    a. Containers should be placed on a concrete or brick footing on firm ground.
    b. Container capacity shall meet or exceed the size specified in the sizing chart for the roof area draining to it.
    c. Containers storing less than 1000 gallons shall use an outlet spigot of ½"; larger containers shall utilize spigots of ¾". The spigot should drain to a hose or pipeline that can outlet to a conveyance BMP.
    d. Containers must have an overflow pipe located below the top of the tank which is directly routed to a conveyance BMP.
    e. The water collected from the gutter shall be filtered with a fine screen prior to discharging to the storage container.
    f. The container should have a valve of at least 2" in diameter to flush sediment out of the tank. This larger valve should not be used to drain the tank because of the rapid rate of draining.

g. The effectiveness of rainwater collection systems is highly dependant on the ability to monitor the system closely for maintenance and needed adjustments.

Rainwater Collection Systems Operation and Maintenance

1. Rainwater collection is a means of managing runoff through storage of roof runoff for irrigation use.
2. Rainwater collection systems include a collection area, a filtering system, a storage device, and an outflow device.
3. The size, components, and configuration of the rainwater system as depicted by the site plan and design details must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.
4. The collection area (e.g., roof) should be routinely inspected by the property owner for debris and other material that could impede the entrance and/or exit of surface flows.
5. The filtering system should be periodically inspected by the property owner for effectiveness and replaced or replenished as recommended by the manufacturer.
6. Consulting with an engineer on the operation and maintenance of these systems is strongly recommended.

Section III-B Stormwater Conveyance BMPs

The stormwater conveyance BMPs collect and convey runoff on the site. When correctly implemented, conveyance BMPs can slow flows and allow some infiltration of stormwater as it travels across a developed site.

To achieve these benefits, at least one-third of the flow path distances from various impervious surfaces to the edge of the property must consist of an open conveyance BMP, limiting the use of pipes and narrow ditches.

The four options for conveyance of stormwater consist of swales, furrows, gardens, and gravel-filled trenches. This section of the manual presents general guidelines for design of the following conveyance BMPs for Medium Impact projects:

1. Swales
2. Conveyance Furrows
3. Conveyance Gardens
4. Gravel Trenches

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1. SWALES

Swales are broad, shallow ditches with gentle slopes. They are generally grassed and designed for easy mowing. Swales should be used on level or gentle sloped ground with grades less than 5%.

The bottom width of a swale should be at least 2'. However, if the swale serves over 5000 square feet of impervious surface, the bottom should be at least 3' wide.

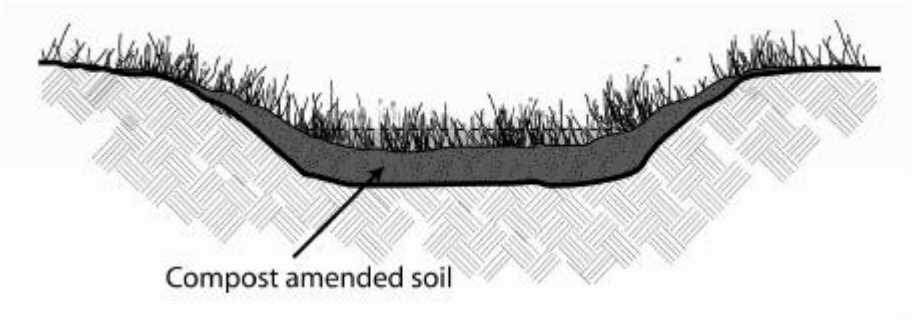

Figure 12 Grassy Swale Cross Section

Swale Operation and Maintenance

Swales are planted or grassed open channels that trap pollutants by filtering and slowing flows, allowing particles to settle out.

The size, placement, composition, and flow paths of the swales as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.

1. Swales must be inspected annually by the property owner and after major storm events to identify and repair any physical defects.
2. When soil is exposed or erosion channels are present, the sources of the erosion or concentrated flow shall be identified and mitigated. Bare spots should be re-vegetated.
3. Sediment accumulation shall be hand-removed with minimum damage to vegetation. Sediment shall be removed if it is more than 4" thick or so thick as to damage or kill vegetation.
4. Inlet shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
5. Annual or semi-annual tilling shall be implemented if compaction or clogging occurs.

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2. CONVEYANCE FURROW

Conveyance furrows are a series of parallel troughs and berms perpendicular to the slope that runoff water flows across from one to another. Conveyance furrows can vary in form, from meandering, irregular, and vegetated to straight and grass-lined, and can be graded and planted to be an amenity to the residence. This option is best for slopes from 15% or more.

1. At a minimum one furrow should be constructed for each foot of vertical drop, with a maximum spacing of 10’ between furrows along the flow path.
2. The total relief of the furrows should be 4” to 10” from bottom of trough to top of berm.
3. To prevent concentration the furrows must be level and run along the contour of the land. Conveyance furrows and berms should be earth or drain rock.
4. The furrows should be vegetated with grass or vegetation appropriate for moist and seasonally dry conditions. See Appendix B for a list of recommended plants.
5. Conveyance furrows must be long enough to intercept all runoff generated from impervious sources.
6. The bottom of the troughs should be a minimum of one foot wide.

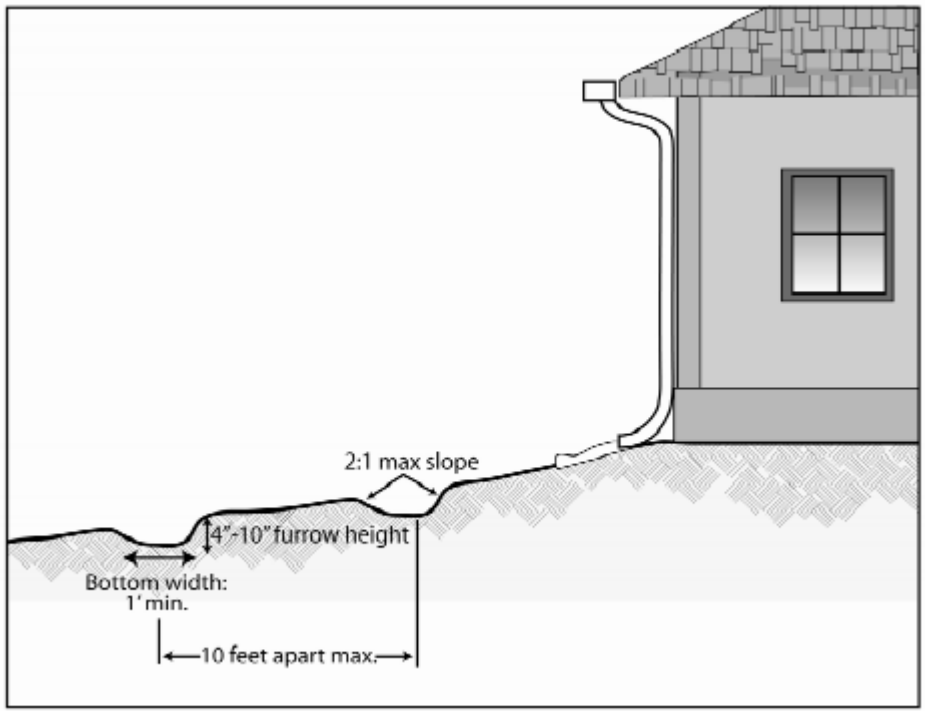

Figure 13 Conveyance Furrow Cross Section

Conveyance Furrow Operation and Maintenance

Conveyance furrows are a series of parallel troughs and berms perpendicular to the slope that runoff water flows across from one to another that can be planted with vegetation grass, or filled with gravel.

The size, placement, and design of the conveyance furrow as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.

1. Chemical fertilizers and pesticides must not be used.
2. Conveyance furrows must be inspected annually by the property owner for physical defects.
3. After major storm events, the conveyance furrows should be checked to see that the flow path has not been clogged with debris.
4. If erosion channels or bare spots within the furrows are evident, they should be stabilized with soil, plant material, and mulch.
5. If planted with grass or other vegetation, a supplemental watering program may be needed the first year to ensure the long-term survival of the conveyance furrows' vegetation.
6. If planted, vegetation should be maintained as follows:
    a. replace all dead vegetation as soon as possible;
    b. remove fallen leaves and debris as needed;
    c. remove all noxious vegetation when discovered;
    d. manually weed without herbicides or pesticides;
    e. mulch to conserve moisture and inhibit weed germination.

3. CONVEYANCE GARDEN

Conveyance gardens are similar to rain gardens but are narrower and part of a continuous ditch or ditch-pipe system.

1. Existing and replacement soil shall be uncompacted to increase infiltration.
2. If the site soil has low permeability, the soil in the bottom of the garden can be replaced or amended with a more permeable soil or amended with compost.
3. Conveyance gardens should be located on level to gently sloped ground. Use caution in locating conveyance gardens on slopes greater than 10%.
4. The bottom of a conveyance garden should be 6" to 12" below the grade of the outlet pipe or ditch.
5. The bottom width of a conveyance garden should taper from the inlet ditch up to a minimum of 3', then taper down to the width of the outlet pipe or ditch.
6. Conveyance gardens serving over 5000 square feet of impervious surface should have a minimum width of 4' at their widest point.
7. The conveyance garden should be planted with vegetation appropriate for moist and seasonally dry conditions. See Appendix C for a list of recommended plants.
8. Overflow shall connect to a designated management area or discharge point.

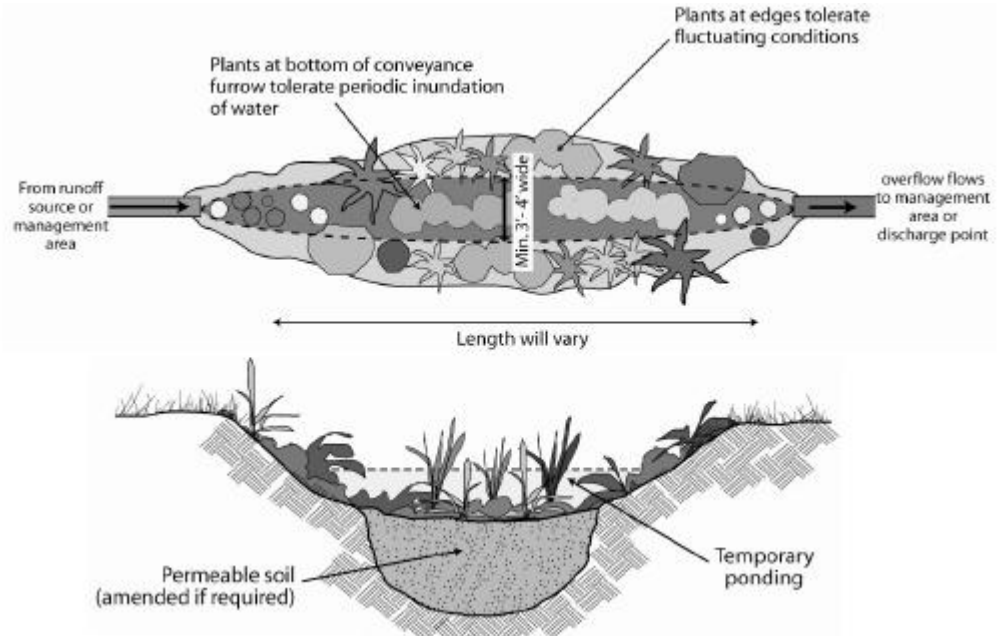

Figure 14 Conveyance Garden Plan View and Cross Section

Conveyance Garden Operation and Maintenance

Conveyance gardens are linear depressions that collect, infiltrate, and convey stormwater from an area of impervious surface to an end-of-line system such as a level spreader.

The size, placement, and design of the conveyance garden as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.

1. Chemical fertilizers and pesticides must not be used.
2. Additional mulch and compost should be added to the soil of the conveyance garden periodically over time.
3. Conveyance gardens must be inspected annually by the property owner for physical defects.
4. After major storm events, the conveyance garden should be checked to see that the overflow system is working properly and is not clogged.
5. If erosion channels or bare spots are evident, they should be stabilized with soil, plant material, and mulch.
6. A supplemental watering program may be needed the first year to ensure the long-term survival of the conveyance garden's vegetation.
7. Vegetation should be maintained as follows:
    a. replace all dead vegetation as soon as possible;
    b. remove fallen leaves and debris as needed;
    c. remove all noxious vegetation when discovered;
    d. manually weed without herbicides or pesticides;
    e. mulch to conserve moisture and inhibit weed germination.

4. GRAVEL TRENCHES

Gravel trenches are excavated trenches filled with loose gravel intended to convey runoff from the runoff management zone to an end-of-line discharge technique such as a level spreader (See Section III-C for a description of level spreaders). Gravel trenches should be used on gently sloped ground with grades less than 5%.

The bottom width of a trench should be at least 2'. Gravel trenches serving over 5000 square feet of impervious surface should be at least 3' wide at the bottom.

The trench should be a minimum of 1 foot deep.

Gravel Trench Operation and Maintenance

1. The size, placement, and composition of gravel trenches as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.
2. Gravel trenches must be inspected annually by the property owner and after major storm events to identify and repair any physical defects.
3. Maintenance and operation of the trench should focus on ensuring the system's viability by preventing sediment-laden flows from entering the device. Excessive sedimentation will result in a plugged or non-functioning facility.
4. Prolonged ponding around the gravel trench may indicate it has become blocked. The existing gravel in the trench should be excavated and replaced.

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Section III-C End-of-Line Discharge BMPs

After stormwater has traveled through a runoff management BMP such as a rain garden, rainwater planter, or infiltration system, it is conveyed through an open conveyance BMP to a discharge point. This point should be at or near the point where water naturally flowed from the site before the permitted development.

In order to eliminate or minimize any impacts associated with the discharge of stormwater from a site, stormwater shall be dispersed utilizing either a level spreader, continued dispersion or conveyance furrows (see Section III-B for a description of conveyance furrows).

This section of the manual presents general guidelines for design of the following discharge BMPs for Medium Impact projects:

1. Quarry Spall Pads
2. Level Spreaders
3. Continued Dispersion

1. QUARRY SPALL PADS

For areas draining less than 1000 square feet, a splash pad constructed of 4" quarry spalls may be used. The pad shall measure at least 4' x 4' and meet the property line setback requirements for level spreaders.

2. LEVEL SPREADERS

Level spreaders are structures that are designed to convert concentrated stormwater flows to sheet flows over a large area. Level spreaders come in many forms but all designs follow the same principle:

1. Concentrated flow enters the spreader through a pipe, ditch or swale.
2. The flow is slowed and energy is dissipated.
3. The flow is distributed throughout a long linear shallow trench or behind a low berm or board.
4. Water then rises and is dispersed over the level spreader.

Two main types of level spreader may be used to disperse flows: **level board spreaders** and **gravel spreader trenches**. The key to either type is for the edge of the spreader to be even and level.

1. A spreader shall have a minimum length of 10' for every 1000' of directly tied impervious surface. For example, to adequately disperse flows from an impervious surface (such as a driveway) that measures 1500 square feet, a level spreader 15' long would be needed.
2. For the outflow of a BMP such as a rain garden, or planter, 2000 square feet of impervious surface may be routed for every 10' of width of the level spreader. For example, a rain garden receiving the runoff from a 4000 square-foot surface should have an overflow leading to a level spreader 20' in length.
3. The maximum length of one level spreader shall be 30'. For areas larger than 3000 square feet of impervious surface that are drained directly by a level spreader, more than one level spreader should be used. When used in conjunction with runoff management and conveyance BMPs such as a rain garden or conveyance furrow, impervious surfaces larger than 6000 square feet should incorporate more than one level spreader.
4. For directly tied impervious areas, a turf or other vegetated flow path of at least 50' in length must be available along the path that runoff will follow upon discharge from the spreader to the nearest property line. For outflows from a BMP such as a rain garden, or planter, a turf or other vegetated flow path of at least 20' in length must be available along the path that runoff will follow upon discharge from the spreader to the nearest property line. Spreaders discharging to a public roadside ditch may be located as close as 5' from the property line.
5. The level spreader should be at least 100' from a critical area such as a stream, wetland or geologically hazardous area, and shall meet the requirements for critical areas detail in the city's Development Code.

2A. Level Board Spreaders

Boards are installed in a trench and serve as the downstream lip so that water can flow out of the level spreader more uniformly. The boards should be stabilized by rebar driven into the ground at regular intervals along the trench. Joints between boards can be constructed by wrapping cloth around both ends of the board.

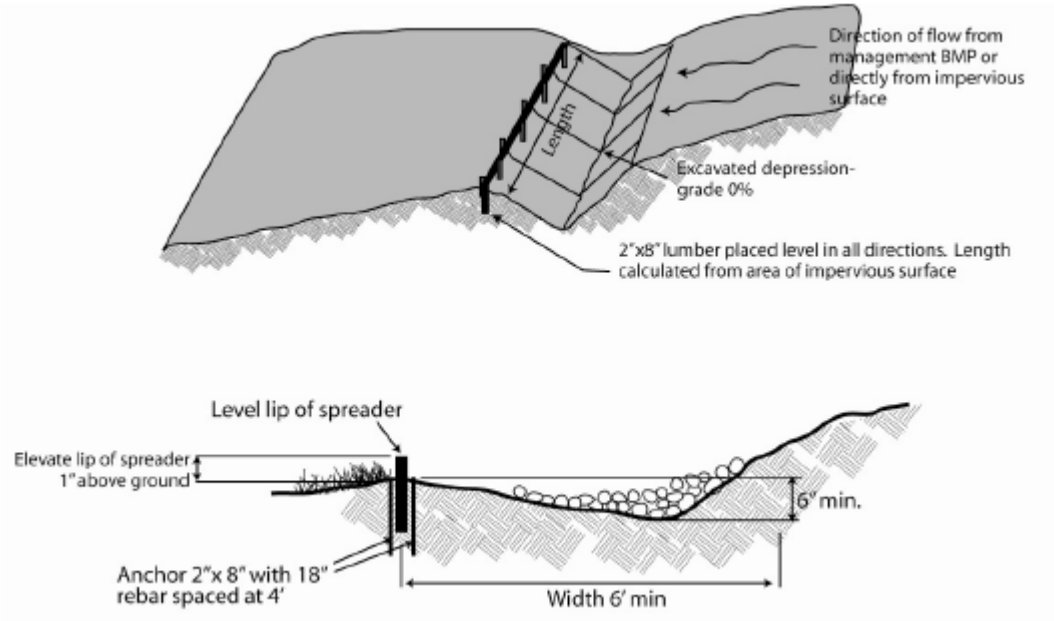

Figure 15 Level Board Spreader

2B. Gravel Spreader Trenches

A gravel spreader trench is a gravel filled channel with a level down slope edge. Water pools in the channel, rises up and flows evenly over the edge of the channel as dispersed sheet flow. The channel should be dug along an elevation contour, which helps make the downstream lip "level." Landscape fabric should be used to underlay the channel and protect the down slope lip. A disadvantage of this type of spreader is that it is very hard to get the lip truly level and keep it that way.

Level Spreader Operation and Maintenance

1. The size, placement, and composition of level spreaders as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.
2. Level spreaders must be inspected annually by the property owner and after major storm events to identify and repair any physical defects.
3. Maintenance and operation of the trench should focus on ensuring the system's viability by preventing sediment-laden flows from entering the device. Excessive sedimentation will result in a plugged or non-functioning facility.
4. When soil is exposed or erosion channels are present, it may mean the level edge of the spreader is no longer level. The level spreader should be regraded to eliminate the problem.

3. CONTINUED DISPERSION

Continued dispersion from level ground, a level spreader, conveyance furrows, filter strip or porous pavement is an appropriate discharge option where at least 100' of flow path through on-site native vegetation allows stormwater to naturally infiltrate and disperse. In some instances, this option may be limited or not allowed if City staff identifies conditions that may concentrate stormwater flows and create downstream problems for public or private properties.

Continued Dispersion Operation and Maintenance

1. The dispersion flow path as depicted by the drainage plan must be maintained and shall not be changed without written approval from the City of Shoreline Development Review Engineer.
2. When soil is exposed or erosion channels are present, the sources of the erosion or concentrated flow shall be identified and mitigated. Bare spots should be re-vegetated with native vegetation.
3. The vegetated surface required for dispersion should be delineated as "vegetation retention area" on the drainage plan.
4. The trees, shrubs, ground cover, and soil conditions in this area shall not be disturbed, except as allowed by the following provisions:
    a. Individual trees that have a structural defect due to disease or other causes, and which threaten to damage a structure, road, parking area, utility, or place of employment or public assembly, or block emergency access, may be topped, pruned, or removed as needed to eliminate the threat.
    b. Dead or fallen trees, tree limbs within 10' of the ground, and branches overhanging a residence may be removed to reduce the danger of wildfire
    c. Noxious weeds (i.e., plant species listed on the State noxious weed list in Chapter 16-750 WAC) and invasive vegetation (i.e., plant species listed as obnoxious weeds) may be removed.
    d. Passive recreation uses and related facilities, including pedestrian, equestrian community and bicycle trails, nature viewing areas, fishing and camping areas, and other similar uses that do not require permanent structures, are allowed if clearing and soil compaction associated with these uses and facilities does not exceed eight percent of the native growth retention area.

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APPENDIX A SAMPLE DRAINAGE PLANS

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Sample Plans

The following pages include sample drainage plans from development situations likely to be encountered.

While each drainage plan should be site specific and address the unique conditions found on the site, these sample plans can be used as general examples for managing stormwater on residential sites.

Example A Large Lot with Full Dispersion

Example B Small Lot Dispersion

Example C Small Lot with Poorly Draining Soils

Example D Large Lot with Well-Drained Soils

Example E Large Lot with Poorly Draining Soils

Note: The following plans are intended as examples only. Each drainage plan should be designed to meet the specific conditions of the site.

Example A Large Lot with Full Dispersion

A single family residential project with a roof area of 2400 square feet and a garage with a roof area of 970 square feet on a 2.5 acre lot.

Step 1: Conduct Site inventory. A thorough inventory of the site is the initial step for developing and implementing an effective site design and drainage plan.

a. The site is gently sloping with 5-7% slopes.

b. There are no seeps, springs or visible drainage paths on-site.

c. There are no environmental critical areas (e.g. wetlands, streams, geologic hazard areas) on the site.

d. The forested portions of the site have native vegetated areas of trees and shrubs and cover more than 50% of the site.

e. The site utilizes an on-site septic system.

Step 2: Site Design. Using the information gathered in the Inventory, align the roads and structures on the site to maximize the preservation of vegetation and retain the existing flow of water on the site to the greatest possible extent.

a. Building envelope and access point are identified.

b. Clearing limits are marked on construction plans.

Step 3: Determine Soil Type. Determine the type of soil on the site. Infiltration is the first choice when feasible. The lot is large with more than half the site in vegetated open space, dispersion is an option.

Step 4: Drainage Plan Design. A drainage plan is developed using the Medium Project Drainage Plan Design Elements section to select options for managing roof water runoff, driveway runoff, conveyance areas, and discharge areas. The sizing chart for each drainage element determines the required dimensions based on the amount of impervious surface draining to it. The following page shows the runoff, conveyance and discharge locations illustrated on the drainage plan for the site. The connection to the community drainage system is shown.

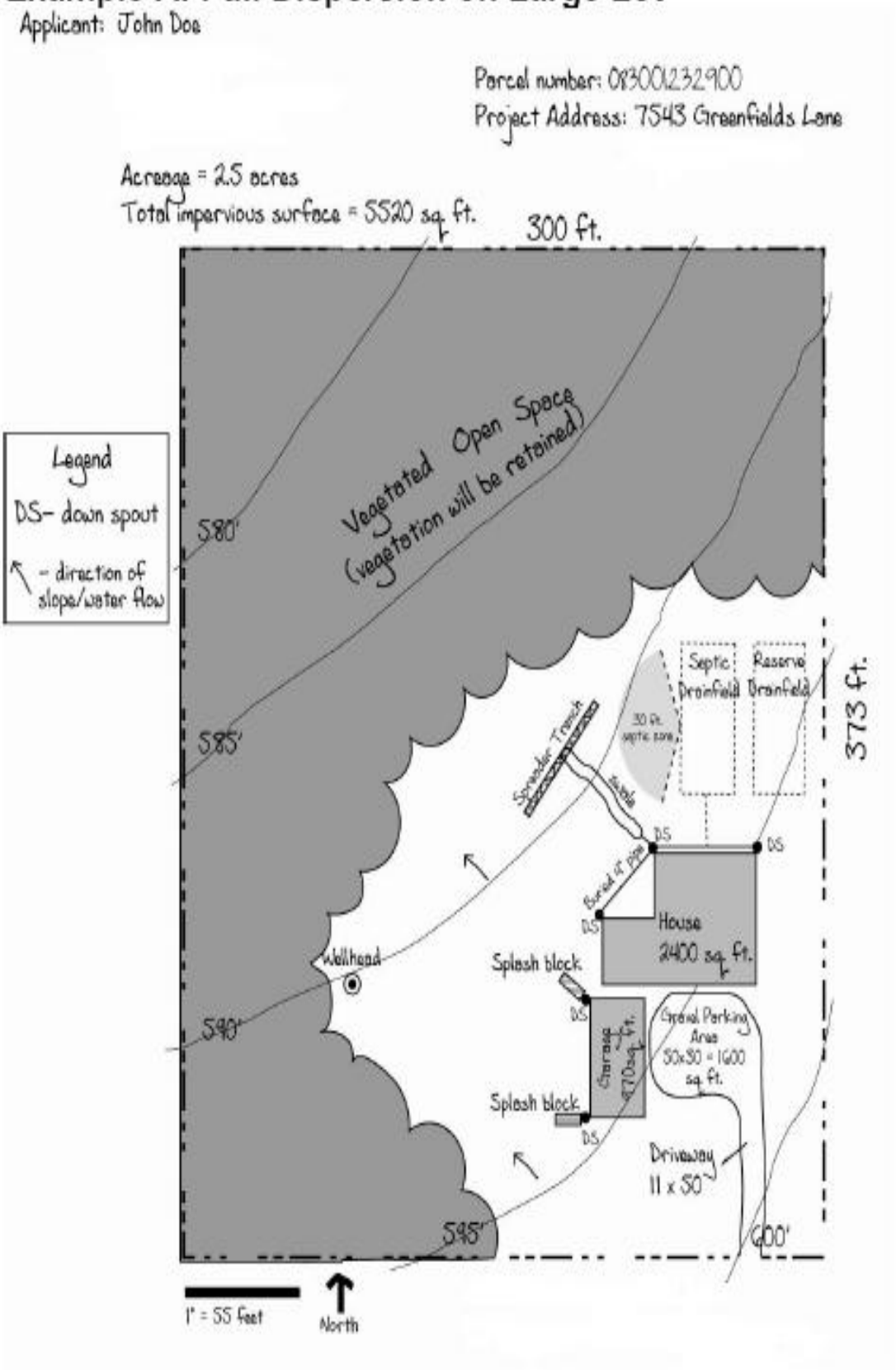
a. Full dispersion of the roof runoff is possible because of the size of the lot; the building envelope and the existing vegetated open space is more than 50% of the lot cover.

b. The house roof runoff is routed through downspouts, pipes and a swale to a spreader trench that is used to disperse the stormwater evenly.

c. Splash blocks in combination with gutters and downspouts are used to disperse garage roof runoff.

d. Runoff from the gravel driveway is dispersed into the surrounding lawn areas.

Example A: Full Dispersion on Large Lot



Example B: Small lot Dispersion

This is an existing single family residential project with a roof area of 2040 square feet, a 1180 square- foot driveway/parking area and a proposed garage with a roof area of 936 square feet on a 0.62 acre lot. As the project adds less than 2000 square feet of new impervious basic dispersion may be an option.

Step 1: Conduct Site Inventory. A thorough inventory of the site is the initial step for developing and implementing an effective site design and drainage plan.

a. The site is nearly level and there are no seeps, springs or visible drainage paths on site.

b. There are no critical areas on the site.

c. The site is a former hayfield and has no existing native vegetated areas but does have an intact ground cover layer of pasture grasses.

d. The site utilizes an on-site septic system.

Step 2: Site Design. Using the information gathered in the Inventory, align the roads and structures on the site to maximize the preservation of vegetation and retain the existing flow of water on the site to the greatest possible extent.

a. Building Envelope and Access Point are identified.

b. Clearing limits are marked on construction plans.

Step 3: Determine Soil Type.

The example site is within the areas identified as having soils suitable for infiltration.

Step 4: Drainage Plan Design. A drainage plan is developed using the Medium Project Drainage Plan Design Elements section to select options for managing roof water runoff, driveway runoff, conveyance areas, and discharge areas. The following page shows the runoff, conveyance and discharge locations illustrated on the drainage plan for the site.

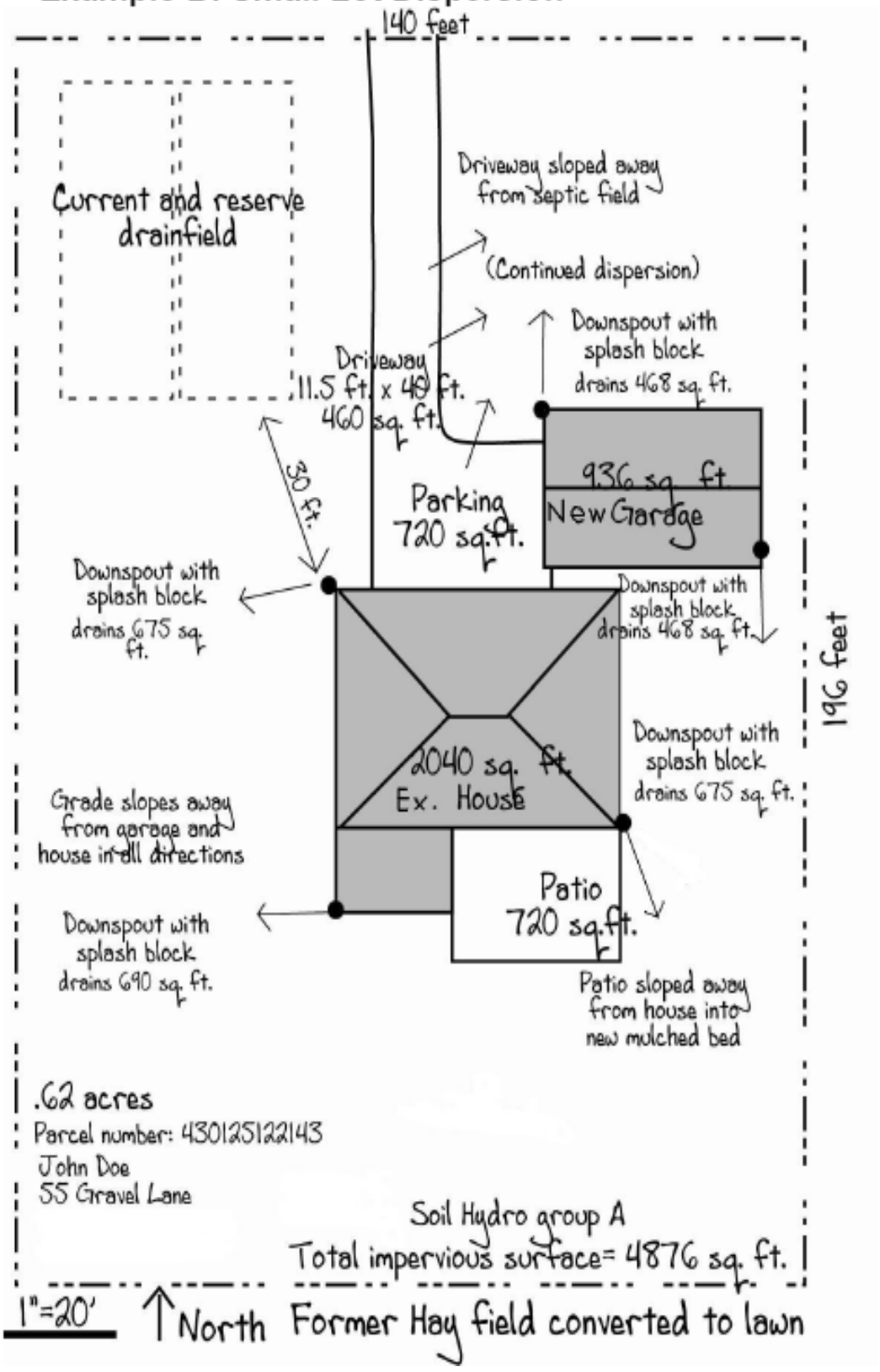
Because this lot is eligible for *Basic Dispersion*, the roof runoff from the house may be managed with downspouts and splash blocks. Note: conveyance and end-of-line discharge BMP's may still be required.

a. No more than 700 square feet of roof area is drained to a single splash block. Size of drainage area is indicated for each dispersion site.

b. A vegetated flow path of at least 50' in length is available along the paths that runoff will follow upon discharge from the splash blocks to the nearest property line.

c. Runoff from the driveway is dispersed into surrounding lawn area.

Example B: Small Lot Dispersion



Example C: Small Lot with Poorly Draining Soils

This example depicts a single family residential project with a roof area of 1854 square feet, a 945 square-foot driveway, and a garage with a roof area of 528 square feet on a 9000 square-foot lot.

Step 1: Conduct Site inventory. A thorough inventory of the site is the initial step for developing and implementing an effective site design and drainage plan.

a. The site is nearly level and there are no seeps, springs or visible drainage paths on site.

b. There are no critical areas on the site.

c. The site is former pasture land and has no existing native vegetated areas.

d. The site has access to public sewer and water systems.

Step 2: Site Design. Using the information gathered in the Inventory, align the roads and structures on the site to maximize the preservation of vegetation and retain the existing flow of water on the site to the greatest possible extent.

a. Building Envelope and Access Point are identified.

b. Site was pre-cleared so defining clearing limits on plan is not an option.

Step 3: Determine Soil Type.

A soils test was performed by a licensed engineer confirming the site soils are type C, not recommended for infiltration.

Step 4: Drainage Plan Design. A drainage plan is developed using the Medium Project Drainage Plan Design BMP's (Section III) to select options for managing roof water runoff, driveway runoff, conveyance areas, and discharge areas. The sizing chart for each drainage element determines the required size of each BMP based on the amount of impervious surface draining to it. The following page shows the runoff, conveyance and discharge locations illustrated on the drainage plan for the site.

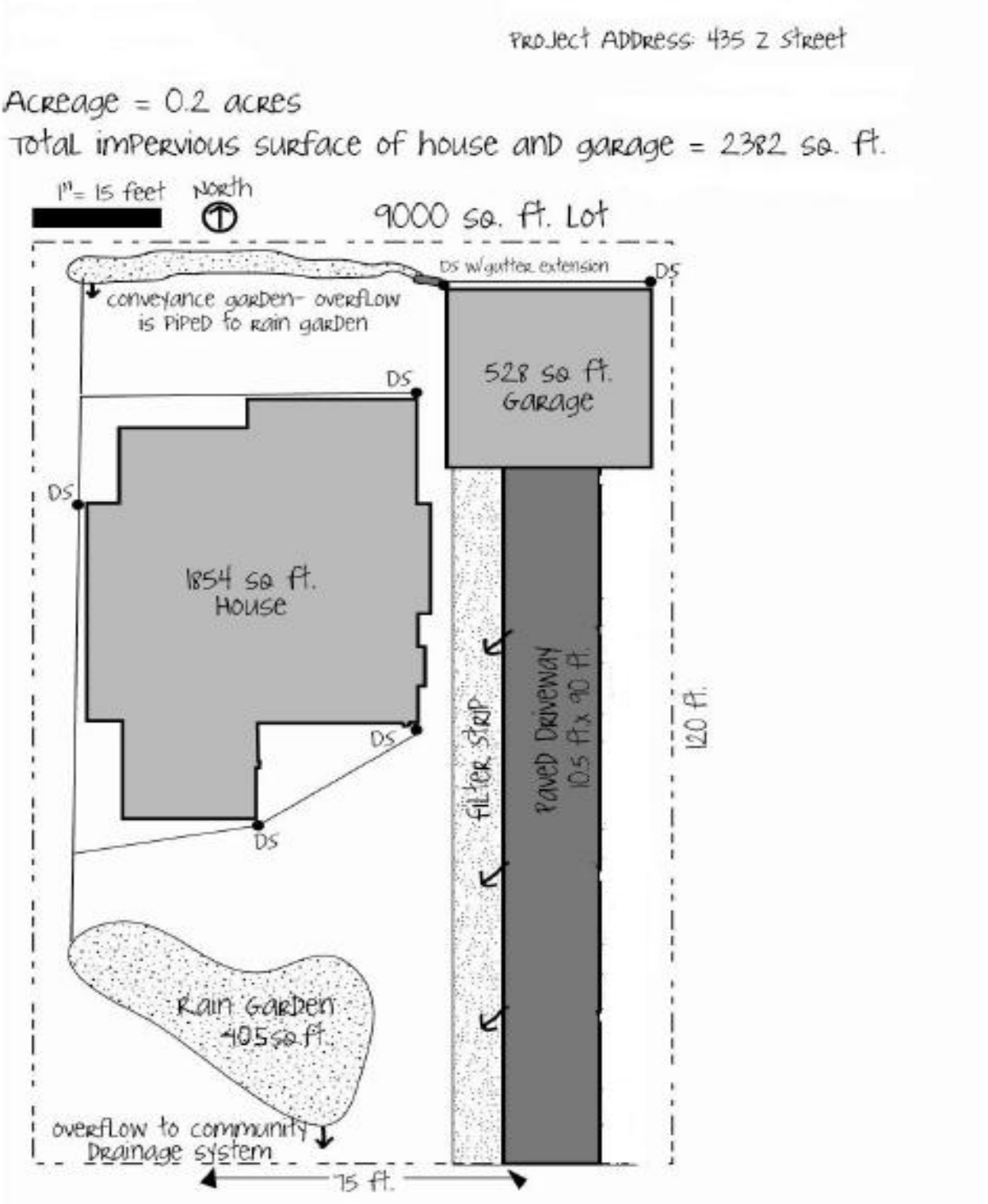
a. The roof runoff from the house is managed with gutters and downspouts that are piped to a rain garden. The surface area of the rain garden is sized at 405 square feet to handle the 2382 square-foot total of roof area (house and garage) according to the sizing table on page 19. The overflow of the rain garden is routed to the existing community drainage system.

b. The roof runoff from the garage is routed through a conveyance garden to slow and infiltrate some water and to provide an amenity along the backside of the house. The overflow of the conveyance garden is piped to the rain garden at the front of the house.

c. The 945 square feet driveway is paved. Because the driveway is less than 2000 square feet, filter strips are all that is needed to manage the driveway runoff. The filter strip areas are at least half the width of the driveway.

d. The connection to the community drainage system is shown.

Example C: Small Lot with Poorly Draining Soils



Example D: Large Lot with Well-Drained Soils

This example shows a single family residential project with a roof area of 3281 square feet and a garage with a roof area of 1875 square feet on a one-acre lot.

Step 1: Conduct Site inventory. A thorough inventory of the site is the initial step for developing and implementing an effective site design and drainage plan.

a. The site slopes gently to the north with 5% slopes or less.

b. There are no seeps, springs or visible drainage paths on-site.

c. There are no critical areas on the site.

d. The site has little native vegetation remaining.

e. The site utilizes an on-site septic system.

Step 2: Site Design. Using the information gathered in the Inventory, align the roads and structures on the site to maximize the preservation of vegetation and retain the existing flow of water on the site to the greatest possible extent.

a. Building Envelope and Access Point are identified.

b. Clearing limits are marked on construction plans.

Step 3: Determine Soil Type.

The example site is located within the area identified as having soils suitable for infiltration.

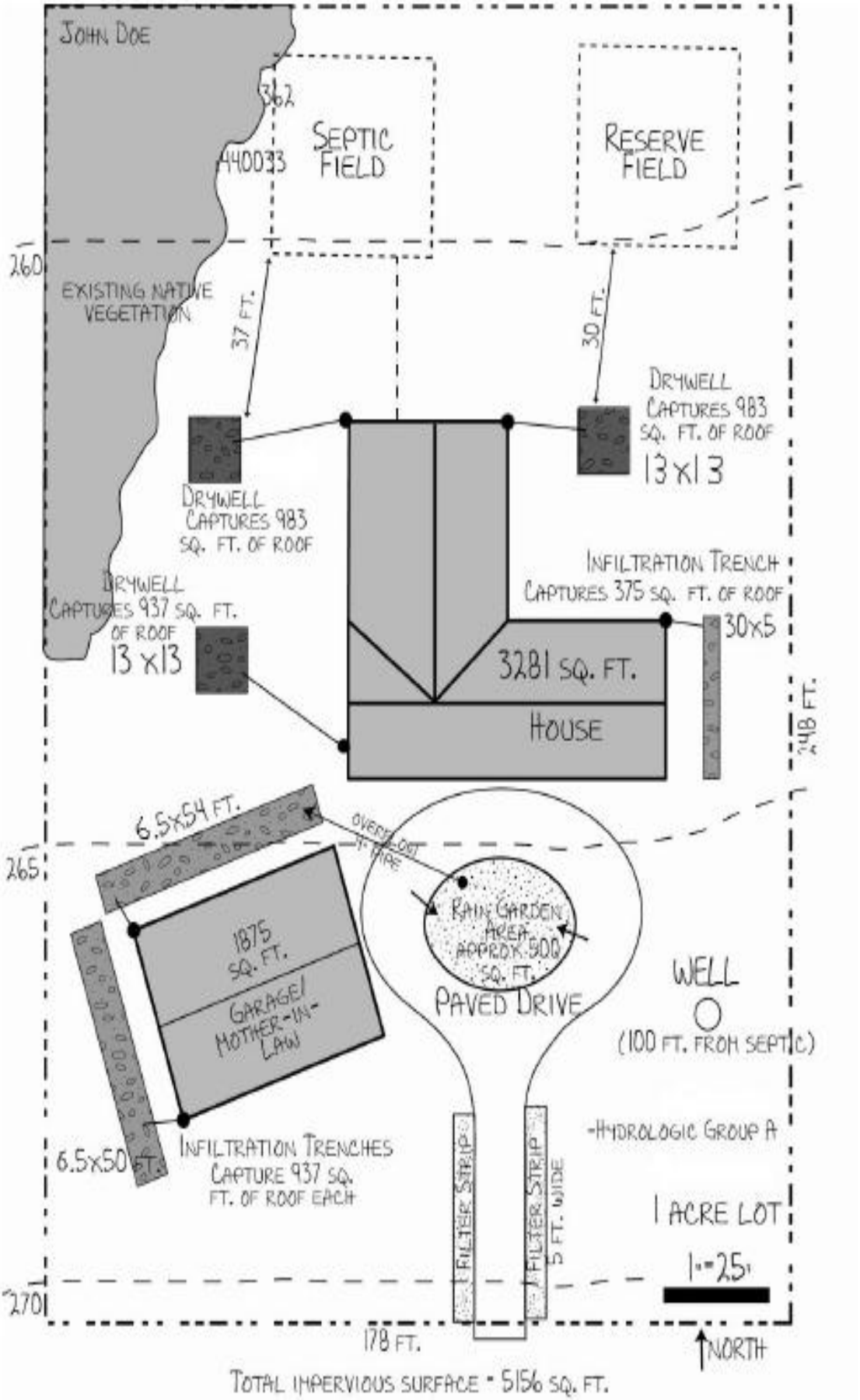
Step 4: Drainage Plan Design. A drainage plan is developed using the Medium Project Drainage Plan Design BMP's (section III) to select options for managing roof water runoff, driveway runoff, conveyance areas, and discharge areas. The sizing chart for each drainage element determines the required dimensions based on the amount of impervious surfaces draining to them. The following page shows the runoff, conveyance and discharge locations illustrated on the drainage plan for the site.

a. Roof runoff is handled by 3 different drywells and an infiltration trench to avoid exceeding the 1250 square feet drainage area limit to a single drywell. The size of the drywells and trench and the area it drains is noted on the plan.

b. Infiltration trenches are used to manage the garage roof runoff. The infiltration trenches are sized for the drainage area draining to them, according to directions on page 26-29. The size of the trenches and the area they drain are noted on the plan.

c. Runoff from the gravel driveway is handled by filter strips and a rain garden. The circular drive is graded to drain to the rain garden.

Example D: Large Lot with Well-Drained Soils



Example E: Large Lot with Poorly Draining Soils

A single family residential project with a roof area of 2496 square feet with an outbuilding with a roof area of 576 square feet on a two-acre lot.

Step 1: Conduct Site inventory. A thorough inventory of the site is the initial step for developing and implementing an effective site design and drainage plan.

a. The site has slopes over 15% draining to the northwest.

b. There is a seep/ wet area along the hillside of the property that seasonally drains to the north.

c. There are no critical areas on the site.

d. The site was logged and has little native vegetation remaining.

e. The site utilizes an on-site septic system and well.

Step 2: Site Design. Using the information gathered in the Inventory, align the roads and structures on the site to maximize the preservation of vegetation and retain the existing flow of water on the site to the greatest possible extent.

a. Building Envelope and Access Point are identified.

b. Clearing limits are marked on construction plans.

Step 3: Determine Soil Type and Stormwater Region.

This example site lies outside of the areas identified as having soils suitable for infiltration. A soils test was performed by a licensed on-site wastewater treatment system designer confirming the site soils are type C, not recommended for infiltration.

Step 4: Drainage Plan Design. A drainage plan is developed using the Medium Project Drainage Plan Design BMP's (section III) to select options for managing roof water runoff, driveway runoff, conveyance areas, and discharge areas. The sizing chart for each drainage element determines the required dimensions based on the impervious surfaces draining to them.

The following page shows the runoff, conveyance and discharge locations illustrated on the drainage plan for the site.

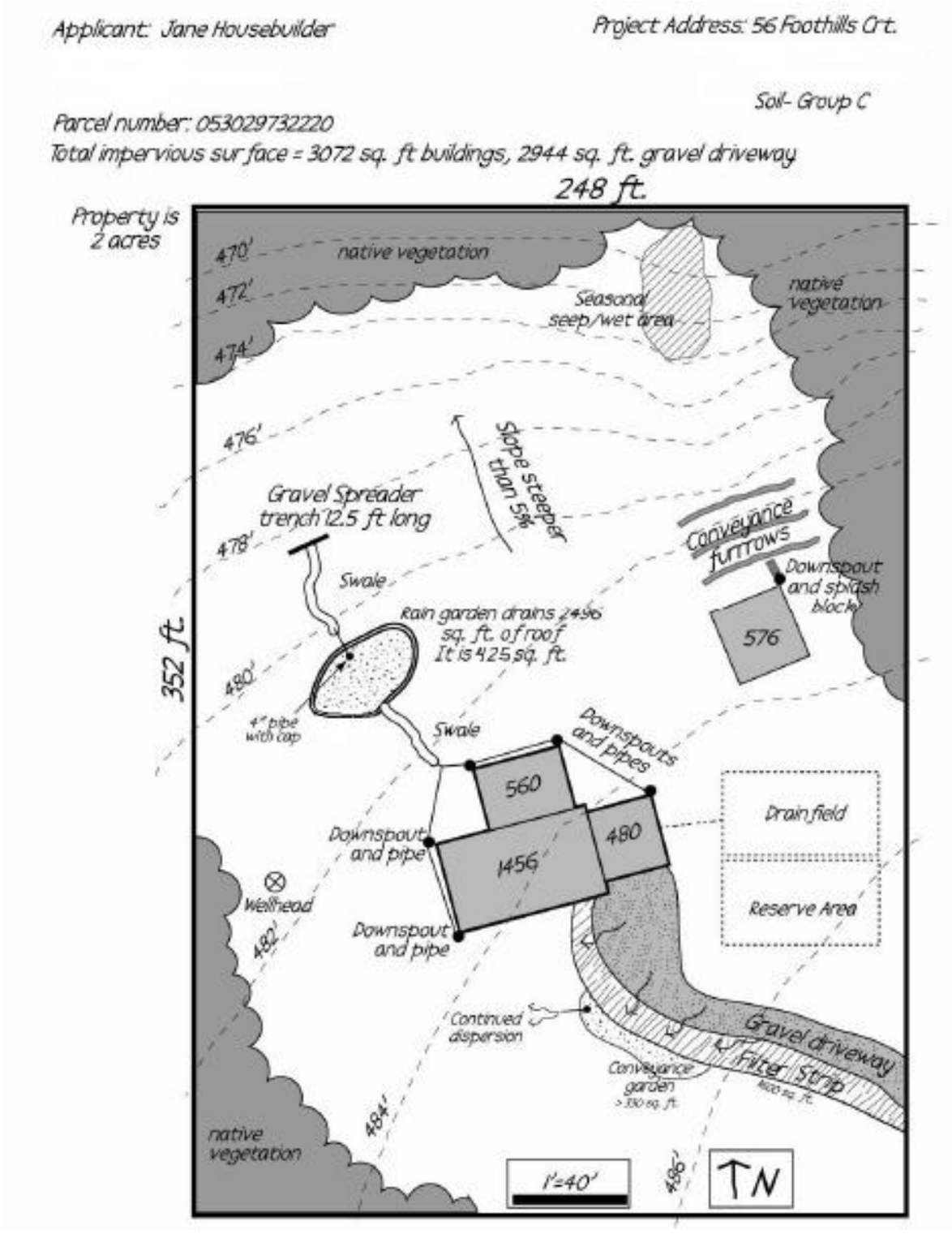
a. Roof runoff of the house is handled by a rain garden sized for the impervious area of the house (according to the sizing information on page 19). The size of the rain garden and the area that it drains is noted on the plan.

b. Swales and pipes are used to convey the roof runoff to the rain garden. A gravel spreader trench is used as end-of- the line discharge.

c. Roof runoff from the outbuilding is managed by a downspout with a splash block that drains to 3 conveyance furrows on the northern slope.

d. The gravel driveway utilizes a Runoff from the gravel driveway is dispersed into the surrounding lawn area.

Example E: Large Lot with Poorly Draining Soils



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APPENDIX B RECOMMENDED PLANT LIST FOR BIORETENTION AREAS

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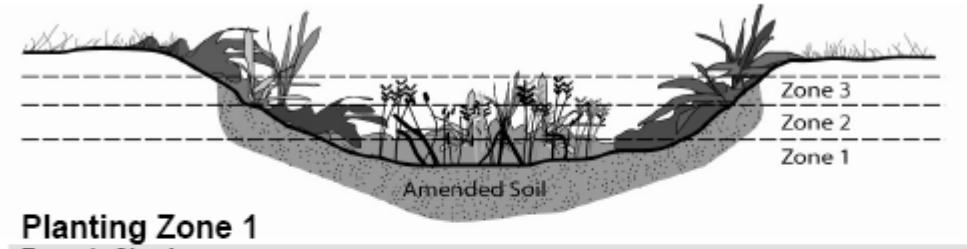
Adapted from the Low Impact Development: Technical Guidance Manual for Puget Sound, Puget Sound Action Team and Washington State, University Pierce County Extension, January 2005

The following native and non-native plants are recommended for use in Rain Gardens, Rainwater Planters, and Conveyance Gardens. Plants utilized in the bioretention areas should be adapted to withstand periods of dryness, but be able to tolerate saturated soil periodically. Conditions in the stormwater management areas will change from very dry during months with little or no rain, to wet or saturated soil following a storm event. The deeper areas of the Rain Garden and Conveyance Garden will be saturated more frequently than the sloping sides. The plants in the Rainwater Planter are at a more uniform depth, but soil moisture within the planter will vary seasonally.

The following list is arranged beginning with plants that thrive in wetter conditions to ones that prefer the slightly drier and higher sides of the Rain Garden or Conveyance Garden. Rainwater Planters should utilize plants from Zone 1 and Zone 2.

Zone 1: Areas of frequent inundation or standing water.
Zone 2: Periodically moist or saturated during larger storms.
Zone 3: Drier soils with infrequent inundation. Transition zone to existing landscape.



Planting Zone 1

Zone 1: Shrubs

Scientific Name	Common Name	Exposure	Mature Size/ Spread
Cornus sericea	Red-osier dogwood	Sun/part shade	to 15 feet
Cornus sericea 'Kelsey'	Dwarf dogwood	Sun	to 1.5 feet
Cornis sericea 'Flaviramea'	Yellow dogwood	Sun/part shade	6-8 feet
Physicarpus capitatus	Pacific ninebark	Sun-part shade	6-13 feet
Spirea douglasii	Douglas spirea	Sun/part shade	4-7 feet
Rubus spectablis	Salmonberry	Shade	5-10 feet

Zone 1: Perennials

Scientific Name	Common Name	Exposure	Mature Size/ Spread
Carex obnuta	Slough sedge	Sun/part shade	1-5 feet
Carex stipata	Sawbeak sedge	Part shade	10 inches-3 feet
Juncus effusus	Common rush	Sun/part shade	1-2 feet
Juncus ensipoluos	Daggerleaf rush	Sun	12-18 inches
Scirpus microcarpus	Small-fruited bulrush	Sun/shade	2-4 feet

Planting Zone 2

Zone 2: Shrubs

Scientific Name	Common Name	Exposure	Mature Size/ Spread
Acer circinatum	Vine Maple	Part shade	to 25 feet
Hammamelis intermedia 'Diane'	Diane Witchhazel	Sun/part shade	10-20 feet/ 10 foot spread
Oemleria cerasiformis	Indian plun	Sun/part shade	5-15 feet
Symphoricarpos albus	Snowberry	Sun/shade	2-6 feet
Rosa nutkana	Nootka rose	Sun/part shade	6-10 feet

Zone 2: Perennials

Scientific Name	Common Name	Exposure	Mature Size/ Spread
Aquilegia formosa	Western Columbine	Sun/part shade	1-3 feet
Asarum caudatum	Wild Ginger	Shade	to 10 inches
Aster subspicatus	Douglas aster	Sun	.5-2.5 feet
Iris douglasiana	Pacific Coast Iris	Sun/part shade	1-2 feet
Tellima grandiflora	Fringecup	Shade	1-3 feet
Hemerocallis fulva	Day Lily	Sun/part shade	1-4 feet
Heuchera micrantha	Purple Palace Heuchera	Sun/part shade	1-2 feet
Geranium sanguineum	Cranesbill	Sun/part shade	1.5 feet

Planting Zone 3

Zone 3: Shrubs

Scientific Name	Common Name	Exposure	Mature Size/ Spread
Arbutus unedo 'Compacta'	Compact strawberry tree	Sun/part shade	to 10 feet
Holodiscus discolor	Oceanspray	Sun/part shade	to 15' feet
Mahonia aquifolium	Tall Oregon Grape	Sun/part shade	6-8 feet
Philadelphus lewis	Mock Orange	Sun/part shade	5-10 feet
Potentilla fruitcosa	Shrubby Cinqufoil	Sun	4 feet
Ribes sanguineum	Red-flowering current	Sun/part shade	8-12 feet
Rhododendron 'PJM'	PJM Rhododendron	Sun/part shade	4 feet
Vaccinium ovatum	Evergreen huckleberry	Part shade/shade	3-15 feet

Zone 3: Perennials and Grasses

Scientific Name	Common Name	Exposure	Mature Size/ Spread
Achillea millefolium	Western Yarrow	Sun	4 inches-2.5 feet
Dicentra formosa	Pacific bleeding-heart	Sun/shade	6-20 inches
Festuca ovina 'Glauca'	Blue fescue	Sun/part shade	to 10 inches
Lupinus spp.	Lupine	Sun	3- 5 feet
Polystichum munitum	Sword Fern	Part shade/shade	2-4 feet
Rudbeckia hirta	Black-eyed Susan	Sun/part shade	3-4 feet
Smilacina racemosa	False Solomon's Seal	Par t shade	1-3 feet

APPENDIX C MEDIUM IMPACT PROJECT SUBMITTAL FORM

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City of Shoreline
Planning and Development Services
17500 Midvale Avenue North
Shoreline WA 98133-4905
(206) 801-2500 fax (206) 801-2788

Surface Water Summary Form

Medium Impact Project

(Refer to Medium Impact Drainage Technical Guidance Pamphlet)

INFORMATION

Please Print. Complete all lines.

Property Address Parcel #	Plan Prepared By:
Contact Name Contact Phone Contact e-mail	Property Owner Address City, St., Zip

Required Submittals: The following are **<u>required</u>** for the drainage plan submittal:

___ Surface Water Summary form – completed and signed

___ Surface Water Assessment Form

___ Stormwater Site Plan – to scale on minimum 24" x 36" paper

___ Stormwater Pollution Prevention Plan – to scale on minimum 24" x 36" paper

___ Soils Report or Infiltration Test Results

Surface Water Summary Form - Medium Impact Project
Site Address: Project Description:
Impervious – Existing (square feet)
Impervious – Proposed Total (square feet)
Impervious – Proposed New (square feet)
Impervious - Proposed Replaced (square feet)
Land Disturbance – Proposed (square feet)
Cut – cubic yards
Fill – cubic yards
Native Vegetation – Proposed Retention (square feet)
Site Area (square feet)
Drainage Basin
Critical Area onsite or abutting: (circle) Landslide Wetland Stream Lake Flood Steep Slopes Erosion Hazard None
Flattest slope on site (Vertical:Horizontal) -
Steepest slope on site (Vertical:Horizontal) -
Soil Type(s)
Infiltration Rate:
Special Drainage Area:
Property Description: (natural features and area, slopes % grades, trees/shrubbery/grass areas, etc.)
Existing Structures and Improvements: (buildings, driveways, patios, sidewalks etc. and areas in square feet or acres)

Surface Water Summary Form - Medium Impact Project

Surface Water Summary Form - Medium Impact Project
Proposed New Structures and Improvements:(buildings, driveways, patios, sidewalks etc. and areas in square feet or acres)
Minimum Requirement #1 Stormwater Site Plan. (Best Management Practices such as native vegetation areas, reduced foot prints, restricted impervious surfaces, limited clearing, infiltration, dispersion etc.)
Minimum Requirement #2 Construction SWPPP: (Best Management Practices such as native vegetation areas, limited clearing, phased construction, etc.)
Minimum Requirement #3 Control Pollutants: (Pollutants such as oils, solvents, food waste, etc.)
Minimum Requirement #4 Preserve Natural Drainage and Outfalls: (Preserve existing drainage, outfall locations)
Minimum Requirement #5 Manage Stormwater Onsite: (Roof downspouts, infiltration, dispersion, retention BMPs)
Maintenance Responsibility: (List permanent BMPs and who will maintain)

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SURFACE WATER PLAN CHECKLIST:

The following information must be included on all medium impact drainage plans:

Identification

- ☐ Name, address, and phone number of applicant
- ☐ Site address
- ☐ Parcel number
- ☐ Dimension of all property lines
- ☐ Street names and existing or proposed property address.
- ☐ North arrow
- ☐ Legend if needed
- ☐ Scale—use a scale that clearly illustrates drainage features and BMPs/measures.
- ☐ Slope details, show at least 5' contours for all slopes steeper than 15%.

Building and Site Development Features

New features in **BOLD/heavier lines**.

- ☐ Footprint of all structures (existing and proposed).
- ☐ Parking, roads, and driveways (existing and proposed).
- ☐ Sport courts, patios, pools and any other paved or impervious surfaces (existing and proposed).
- ☐ Location of any retaining walls and rockeries (existing and proposed).
- ☐ Existing or proposed septic system, including all system components and both primary and reserve drain fields.
- ☐ Utility structures (poles, fire hydrants, etc.).
- ☐ Existing easements.
- ☐ Existing wells or wells to be abandoned.
- ☐ Newly created vegetated areas.
- ☐ Remaining vegetated open space that will remain undisturbed.

Natural Features and Critical Areas

For a map detailing the critical areas on your site, visit the permit counter at Planning and Development Services.

- ☐ Development. Development within 200' of a critical area may require an engineered drainage plan.
- ☐ Existing natural features of the property (woods, pasture, brush).
- ☐ Location of all existing and proposed ditches, swales, pipes, etc.
- ☐ Delineation of all streams, wetlands, lakes, closed depressions, or other water features (including any required buffer widths).
- ☐ Delineation of all flood hazard areas, erosion hazard areas, steep slope hazard areas, landslide hazard areas, and their buffers and building setback lines.

Stormwater Management Information

In addition to the general information listed above, the following additional information is required on drainage plans that include installation of stormwater BMPs:

- ☐ Show delineation and dimensions of impervious surfaces and pervious surfaces, both existing and new.
- ☐ Show location and dimensions of runoff management BMP methods such as, detention ponds and vaults, infiltration trenches, drywells, rain gardens, permeable pavements, rain water storage tanks for managing stormwater from all impervious surfaces.
- ☐ Show delineation and dimensions of the flow path of stormwater through the site - from the runoff management BMPs, to conveyance BMPs, to end-of-line discharge BMPs.
- ☐ Show setback lengths between stormwater management BMPs and any property line, structure, well, steep slope, stream, wetland, or septic system including drain fields.

Written Surface Water Assessment

The written drainage assessment is a supporting document of the medium project drainage plan and includes the following information:

Property and Project Description:

- ☐ Property Description: Describe the natural features of the parcel (i.e. woods, pasture, brush) and give the approximate area covered by those features.
- ☐ Existing Structures/Improvements: List any existing buildings, driveways (dirt, gravel, etc.), sidewalks, etc. and their area size in square feet or acres.
- ☐ New Structures Improvements: List new buildings and their sizes along with any size changes in existing driveways, parking areas, landscaped areas, etc.
- ☐ Future Structures/Improvements Planned: If you wish to have drainage review waived for future structures/improvements on this parcel, you must list them (with dimensions) in this section. Show their locations on the plot plan.
- ☐ Remaining Undisturbed Land: List and provide the size of the land (woods, pasture) not covered by buildings or improvements.
- ☐ Proposed Drainage Plan Narrative: A description of proposed stormwater management BMPs shown on the drainage plan and how they were selected with rationale. Please include details on the impervious surface draining to each BMP, and how each BMP was sized.
- ☐ Also include information on the end-of-line discharge and conveyance BMPs used with rationale for their selection.